PUBLIC DOCUMENT . . . . No. 33.

TENTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1892.

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Commonwealth of Massachusetts.

BOSTON, Jan. 11, 1893.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Tenth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,

Secretary.

MASSACHUSETTS STATE

AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

STATION STAFF.

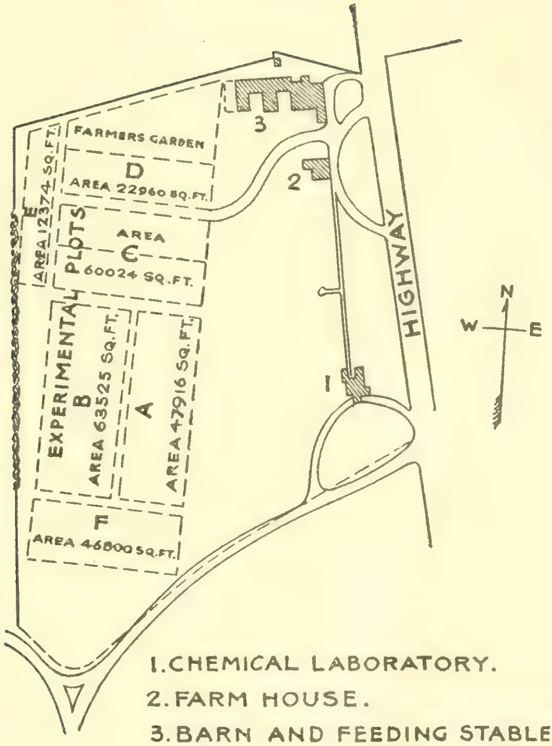
C. A. Goessmann, Ph.D., LL.D., *Director and Chemist*,	.	Amherst.
J. B. Lindsey, Ph.D., *Associate Chemist (Feeding Department)*,		Amherst.
J. E. Humphrey, B.S.,* *Vegetable Physiologist (Mycologist)*,	.	Amherst.

Assistants.

R. B. Moore, B.S.,†	*General and Analytical Chemistry.*
C. S. Crocker, B.S., ...	" " " "
H. D. Haskins, B.S., ...	" " " "
C. H. Jones, B.S., ...	" " " "
R. H. Smith, B.S., ...	" " " "
E. B. Holland, B.S., ...	" " " "
F. L. Arnold, B.S., ...	*Field Experiments.*
C. H. Johnson, B.S., ...	*Stock Feeding.*
David Wentzell, ...	*Farmer.*

* Resigned Jan. 1, 1893.

† Resigned July 1, 1892.



1. CHEMICAL LABORATORY.
2. FARM HOUSE.
3. BARN AND FEEDING STABLES.

·MAP·OF·LAND·LEASED·TO·THE·

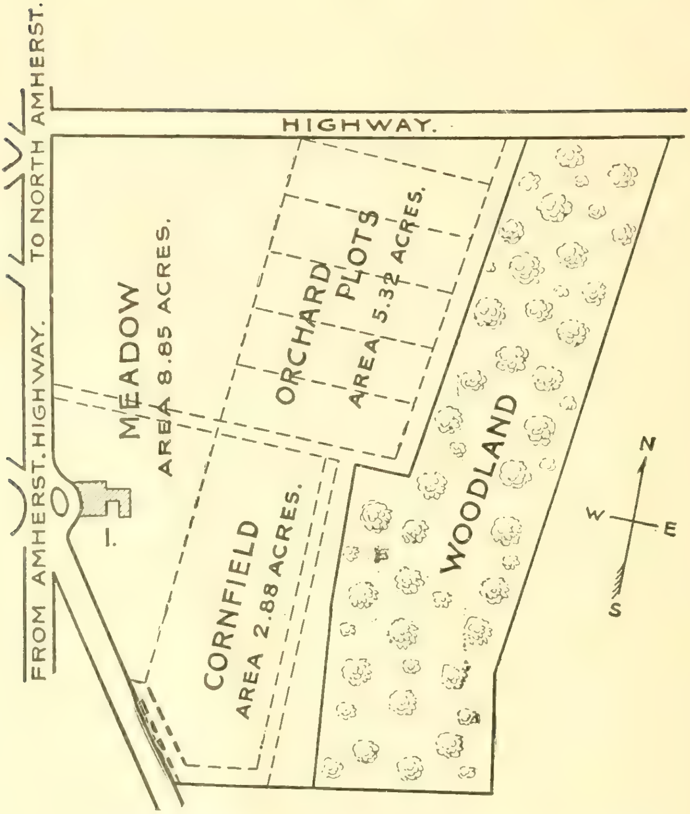
·MASSACHUSETTS·EXPERIMENT·STATION·

·FROM·THE·

·AGRICULTURAL·COLLEGE·FARM·

·WEST·OF·THE·HIGHWAY·

·AREA·TAKEN··17.72·ACRES·



I. AGRICULTURAL & PHYSIOLOGICAL LABORATORY.

MAP · OF · LAND · LEASED · TO · THE
MASSACHUSETTS · EXPERIMENT · STATION
· FROM · THE ·
AGRICULTURAL · COLLEGE · FARM
EAST · OF · THE · HIGHWAY
AREA · TAKEN · 30.52 · ACRES

TENTH ANNUAL REPORT OF THE DIRECTOR

OF THE

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN: — The general condition of the State Agricultural Experiment Station may be considered to-day to be as satisfactory as at the close of the preceding year.

The buildings are on the whole in a fair state of preservation, considering their respective ages and previous conditions.

The arrangements for experiments in stock feeding have been improved in various directions, to provide for actual trials regarding the rate of digestibility of some new feed stuffs.

The number of silos has been increased to three, to admit of contemporaneous observations with different kinds of ensilage.

The outfit in apparatus of the chemical laboratory has been materially enlarged, to meet the growing demand for the analyses of dairy products, of imitations of butter, and of commercial feed stuffs.

A favorable season has contributed largely towards a satisfactory termination of a series of field experiments.

The different lines of observation from time to time presented for your consideration and endorsement have received their due attention to the full extent of existing resources, and as far as circumstances have rendered it practicable.

The co-operative tests in the vegetation house regarding the effect of different kinds and combinations of plant food

on the general character of certain field and garden crops, as well as on certain characteristics of the roots of leguminous plants, have added a new and interesting feature to the work of the station.

Prof. J. E. Humphrey has continued his observations regarding certain diseases of garden crops and fruits. A description of his work concerning some diseases of the cucumber, the black-knot of the plum, etc., accompanied by interesting illustrations, form a part of this report, Part II., 10.

Dr. J. B. Lindsey, a graduate of the Massachusetts Agricultural College, and former assistant in the Massachusetts State Experiment Station, who has lately closed a three-years course of study at the University of Göttingen and Zurich, and whose services have been secured by a vote of the Board at the July meeting, has entered upon his duties as associate chemist. The supervision and management of the stock-feeding department has been assigned to him as his special duty.

The work carried on at the station during the past year, 1892, has been reported in detail upon the succeeding pages in the following order: —

Part I.

On Feeding Experiments.

I. Feeding experiments with milch cows (two).

1. Winter feeding experiments with milch cows: —
   Dent corn *vs.* sweet corn.
   Corn meal *vs.* maize feed (Chicago).
2. Summer feeding experiments with milch cows: —
   Green feed: Rye, Canada peas and oats, summer vetch and oats, fodder corn and serradella.
   Grain feed: Wheat bran, Buffalo gluten feed, cotton-seed meal.
3. Creamery record of the station for 1891 and 1892.
4. Analyses of milk of different breeds of cows by Babcock mode.
5. Discussion on fodder articles and fodder supplies: —
   Home-raised fodder articles
   Commercial feed stuffs.
6. Analyses of fodder articles made at the station in 1892.

II. Feeding experiments with steers (two).
III. Feeding experiments with lambs.
IV. Feeding experiments with pigs (two).
V. Compilation of the amount of digestible nutrients consumed daily in the different feeding experiments made at the station, 1886–92, by Dr. J. B. Lindsey: —

1. Milch cows.
2. Steers.
3. Lambs.

Part II.

On Field Experiments and Observations in Vegetable Physiology and Pathology.

1. Field experiments to ascertain the effect of the exclusion of every form of nitrogen containing manurial matter from the fertilizer applied for the production of a leguminous crop, soja bean, on its yield per acre (Field A).
2. Field experiments with prominent varieties of grasses and with grass mixtures under fairly corresponding circumstances (Field B).
3. Field experiments regarding the effect of different combinations of commercial fertilizers on the yield of some prominent garden crops (Field C).
4. Observations regarding the adaptation of a variety of more or less reputed fodder plants new to our section of the country (Field D).
5. Field experiments with different commercial phosphates to study the economy of using the cheaper natural phosphates or the more costly acidulated phosphates (Field F).
6. Field experiments with mixed forage crops for green fodder and hay, vetch and oats, Canada peas and oats, soja bean, serradella, fodder corn (Fields G, H and I).
7. Observations on permanent grass lands (meadows).
8. Report on general farm work.
9. Report of Prof. James E. Humphrey on various diseases of plants, with observations in the field and vegetation house.

Part III.

Special Work in the Chemical Laboratory.

I. Communication on commercial fertilizers.

1. General introduction.
2. Laws for the regulation of trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1892, to May 1, 1893.
4. Analyses of licensed fertilizers (185).
5. Analyses of commercial fertilizers and manurial substances sent on for examination (114).
6. Miscellaneous analyses (9).

II. Analyses of milk sent on for examination (113).

III. Analyses of water sent on for examination (109).

IV. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse materials used for fertilizing purposes.

V. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.

Meteorological Observations.

The periodical publications of the station have been as frequent as in preceding years; four bulletins, from ten to eleven thousand copies each, and eight circulars of official analyses, seven thousand copies each. The interest in these publications is steadily increasing on the part of farmers, and the growing interest of the press is well illustrated by our numerous exchanges of periodical publications from home and abroad, as may be seen from a subsequent statement.

It gives me pleasure, before concluding, to express to you my due appreciation of the faithful and substantial support I have received from all parties engaged with me in the work accomplished at the station. With the assurance of my sincere thanks for your kind encouragement and indulgence, permit me to sign,

Yours very respectfully,

C. A. GOESSMANN,

Director of the Massachusetts State Agricultural Experiment Station.

PART I.

ON

FEEDING EXPERIMENTS.

I. Feeding Experiments with Milch Cows (two).
II. Feeding Experiments with Steers (two).
III. Feeding Experiments with Lambs.
IV. Feeding Experiments with Pigs (two).
V. Compilation of the Amount of Digestible Nutrients consumed Daily in the Different Feeding Experiments.

I.

FEEDING EXPERIMENTS WITH MILCH COWS (TWO).

1891–92.

---

1. Winter feeding experiments with milch cows: —

   Dent corn *vs.* sweet corn.
   Corn meal *vs.* maize feed (Chicago).

2. Summer feeding experiments with milch cows: —

   Green feed: Rye, Canada peas and oats, summer vetch and oats, fodder corn and serradella.
   Grain feed: Wheat bran, Buffalo gluten feed, cotton-seed meal.

3. Creamery record of the station for 1891 and 1892.
4. Analyses of milk of different breeds of cows by Babcock's mode.
5. Discussion on fodder articles and fodder supplies.

   Home-raised fodder articles.
   Commercial feed stuffs.

6. Analyses of fodder articles made at the station in 1892.

Introduction. — From preceding annual reports it may be noticed that of late our attention has been directed towards actual feeding trials with a series of concentrated commercial feed stuffs comparatively new in our local markets. Their more general appearance in recent times rendered it desirable, in the interest of our dairy industry, to ascertain their comparative feeding effects, as well as their special economical merits, in our present conditions of food supplies for the production of milk and of meat.

These articles were as a rule compared with each other as well as with other standard feed stuffs, as far as practicable under otherwise corresponding circumstances. They were usually fed in connection with the same kinds of grain feed and of coarse fodder articles.

The results obtained with Chicago gluten meal, old and

new process linseed meal, dried brewer's grain when fed in connection with corn meal or corn and cob meal or wheat bran or cotton-seed meal, or as substitutes of one or the other of these articles, have already been described in previous reports (VIII. and IX.).

During our last trials Chicago maize feed and Buffalo gluten feed have served as a new constituent of our grain feed ration for all classes of animals.

It has been our aim to secure genuine articles of both descriptions. The exceptionally high price of corn meal at the beginning of the year (thirty dollars a ton) rendered it advisable to look for some cheaper suitable commercial feed stuff, which might serve, in combination with other current, concentrated commercial feed stuffs, as a substitute for the former. Our results are on the whole quite encouraging, as may be seen from an examination of our subsequently described feeding experiments with various kinds of animals.

1. Winter Feeding Experiments with Milch Cows.

November, 1891, to March, 1892.

[Dent corn *vs.* sweet corn; corn meal *vs.* maize feed (Chicago).]

The experiments here under discussion were planned for the purpose of comparing the food value of a reputed variety of "dent corn" with that of a standard variety of "sweet corn," when used as the principal coarse fodder constituent in the daily diet of milch cows, either in the form of "ensilage," or, in a more advanced state of growth, in that of "stover." "Pride of the North" was selected as the representative of dent corns, and "Stowell's Evergreen" as that of sweet corns; both kinds of corn were used in all cases in corresponding stages of growth.

The exceptionally high market price of the corn meal at the beginning of our experiment (thirty-one dollars per ton of two thousand pounds) rendered its substitution in the daily diet of milch cows desirable for economical reasons. The Chicago variety of "maize feed" was chosen for that purpose. This comparatively new feed stuff is one of the waste products of corn obtained in connection with the manufacture of glucose sugar. The "maize feed" sold at

the time at twenty-five dollars per ton of two thousand pounds. The commercial value of its fertilizing constituents, nitrogen, phosphoric acid and potash exceeded those contained in the corn meal from six to seven dollars per ton, making a difference at the time of twelve dollars in the *net cost* of both kinds of fine or grain feed. A successful attempt at using "maize feed" in place of corn meal in the daily diet of milch cows could not fail to secure a material reduction in *the net cost* of the grain feed portion of the *daily fodder ration.*

From six to eight cows, grades of various descriptions and of different milking periods, were selected for the trial. Some of these animals served a shorter period than others, on account of a too far advanced stage of lactation. Our record on this occasion is confined to four cows, which took part, with but one exception, from the beginning of observation.

1. History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).	Number of Months on Trial.
Clarissa, .	Grade Shorthorn, .	8	June 2, 1891,	7–8	4
Cora, .	Grade Jersey, .	8	Mar. 14, 1891,	9–10	5
Lucy, .	Grade Ayrshire, .	6	Apr. 16, 1891,	11–12	5
Gem, .	Grade Shorthorn, .	5	Dec. 6, 1891,	14–15	3½

2. Description of Fodder Articles.

The *grain feed portion* of the daily diet consisted at different times either of *corn meal*, *wheat bran* and *maize feed* (Chicago), or of *maize feed*, *wheat bran* and *cotton-seed meal*.

The mechanical condition of these various feed stuffs was good, and their chemical composition in every case a fair one, as may be seen from an abstract of the average result of our analyses. The Chicago maize feed was of a somewhat coarser texture than either of the other articles. It represents the dried grain residue of the maize kernels after the principal part of its starchy material has been removed, and contains more or less of the broken-up skins of the kernels.

Analyses of Fine Feed used.

[Grain Feed.]

Food Analyses.	Corn Meal.	Wheat Bran.	Maize Feed.	Cotton-seed Meal.
Moisture at 100° C.,	13.26	10.01	8.70	7.05
Dry matter,	86.74	89.99	91.30	92.95
	100.00	100.00	100.00	100.00
Analyses of Dry Matter.				
Crude ash,	1.72	6.58	0.78	5.40
" cellulose,	2.28	11.77	7.97	6.15
" fat,	4.90	5.04	7.37	13.82
" protein,	12.94	18.06	27.55	38.79
Non-nitrogenous extract matter,	78.16	58.55	56.33	35.84
	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4¼ cents, per pound.]

Fertilizer Analyses.	Corn Meal.	Wheat Bran.	Maize Feed.	Cotton-seed Meal.
Moisture,	13.26	10.01	8.70	7.05
Nitrogen,	1.79	2.60	4.03	5.77
Phosphoric acid,	0.71	2.85	0.70	2.33
Potassium oxide,	0.44	1.63	0.43	1.72
Valuation per 2,000 pounds,	$6.55	$12 40	$13 25	$21 42

The coarse feed-stuffs used in the daily diet consisted on this occasion either of a good English hay with sugar beets, or of one-fourth of a daily ration of a good English hay with all the ensilage the animal would consume, or of a well-cured corn stover. The hay consumed throughout the experiment was of the same fair quality.

The corn ensilage was obtained in part from a dent corn variety, "Pride of the North," and in part from a sweet corn variety, "Stowell's Evergreen." The same varieties of corn furnished the corn stover. Both kinds of corn were of a corresponding stage of growth when secured for the

production of ensilage or of stover. In case of ensilage, the corn was cut in both cases when the kernels began to glaze; the whole plant was reduced to pieces from one to one and one-half inches in length, before being filled into the silo. The latter was filled as rapidly as the supply of material admitted. Both silos were covered in the same way (see previous report). They were of the same size and contained about the same quantity of cut ensilage corn (whole plant).

The corn stover was obtained in both instances from the matured crops, which were cut about ten days later than for ensilage. The ears were separated from the stalks and the latter carefully field-cured, and subsequently cut in a similar way as the ensilage for the silo, before being fed. The stover from sweet corn retained under otherwise corresponding circumstances more moisture than that from the dent corn; it was for this reason more liable to mould than the former. The ensilage from sweet corn was, however, fully equal in color and flavor to that from the dent corn. Both were highly relished by the animals on trial.

The chemical composition of the several coarse fodder articles used in our experiment is stated in the following tabular record: —

Analyses of Coarse Fodder Articles used.

FOOD ANALYSES.	Hay.	* Sweet Corn Stover.	† Dent Corn Stover.	* Sweet Corn Ensilage.	† Dent Corn Ensilage.	Sugar Beets.
Moisture at 100° C, .	9.72	41.62	20.10	84.30	79.92	85.27
Dry matter, . .	90.28	58.38	79.90	15.70	20.08	14.73
	100.00	100.00	100.00	100.00	100.00	100.00
Analyses of Dry Matter.						
Crude ash, . . .	6.43	9.76	6.12	6.32	4.99	5.95
" cellulose, . .	32.28	37.79	33.72	29.32	27.19	6.49
" fat, . . .	2.49	2.44	2.51	7.36	3.29	0.66
" protein, . .	9.54	6.08	7.75	7.86	8.29	10.97
Non-nitrogenous extract matter, . .	49.26	43.93	49.90	49.14	56.24	75.93
	100.00	100.00	100.00	100.00	100.00	100.00

* Stowell's Evergreen. † Pride of the North.

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Hay.	Sweet Corn Stover.	Dent Corn Stover.	Sweet Corn Ensilage.	Dent Corn Ensilage.	Sugar Beets.
Moisture,	9.72	41.62	20.10	84.30	79.92	85.27
Nitrogen,	1.38	0.57	0.99	0.20	0.27	0.26
Phosphoric acid,	0.36	0.20	0.29	0.087	0.14	0.10
Potassium oxide,	1.57	1.00	1.40	0.41	0.33	0.48
Valuation per 2,000 pounds,	$5 95	$2 83	$4 55	$1 06	$1 26	$1 32

3. Mode of Feeding.

The time occupied by the experiment is divided into five feeding periods, varying from two to five weeks in length. The *total weight* of the *daily grain feed ration remained the same throughout the entire trial*, namely, *nine pounds.* This amount consisted during the first feeding period, November 8 to November 23, of three pounds each of maize feed (Chicago), wheat bran and corn meal, and during the remaining four feeding periods of three pounds each of Chicago maize feed, wheat bran and cotton-seed meal. One-half of the daily grain feed ration was fed at the time of milking in the morning with one-half of the coarse feed, and the other half with the remainder of the coarse feed at the milking time toward evening.

The *total* amount of the daily *coarse feed ration* depended on the individual appetite of the animals, and on the character of the fodder articles fed. During the first feeding period, when English hay and sugar beets constituted the daily coarse feed ration, the daily consumption of roots was limited per head in all cases to fifteen pounds, while the daily quantity of hay consumed was decided by the appetite of the animal, varying in case of different animals from twelve to sixteen pounds.

During the second and the third feeding periods nothing but corn stover served as coarse feed in the daily diet. The amount of stover from Stowell's Evergreen sweet corn con-

sumed per day has varied in case of different animals from twelve and one-half to seventeen pounds per head; while the daily consumption of the stover obtained from the dent corn variety, Pride of the North, has varied per head from ten to thirteen and one-half pounds. The difference in the amount of both kinds of stover consumed is evidently mainly due to their different state of moisture, as may be noticed by comparing in both cases the total amount of dry matter contained in the daily diet consumed during the second and third feeding periods.

Corn ensilage and English hay constituted the coarse fodder of the daily diet during the fourth and fifth feeding periods. The amount of English hay fed per day in this connection was limited in all cases to five pounds per head; that of both kinds of the ensilage was governed by the appetite of each animal. Dent corn ensilage was fed in connection with English hay, as stated during the fourth feeding period, and the ensilage from the sweet corn during the fifth.

The daily consumption of the ensilage from the sweet corn varied per head in case of different animals from twenty-four to forty-three pounds, and that of the ensilage from the sweet corn from thirty-five to fifty-three pounds. This difference in the weights of both kinds of ensilage consumed in case of the same animal, is materially due to the same circumstance as has been pointed out previously with reference to similar facts noticed concerning the consumption of both kinds of corn stover. The ensilage of the dent corn contains twenty per cent. of dry vegetable matter and eighty per cent. of water, and the ensilage of the sweet sixteen per cent. of dry vegetable matter and eighty-four per cent. of water. The cows were watered twice a day, about two hours after feeding time.

The daily fodder rations below described represent the *average composition* of the daily diet used per head during the stated five succeeding feeding periods.

Average Composition of the Daily Fodder Rations used during the Five Successive Feeding Periods (1891–92).

I.

November 8 to November 23.

Corn meal (pounds),	3.00
Wheat bran,	3.00
Maize feed,	3.00
Hay,	14.35
Sugar beets,	15.00
Nutritive ratio,	1 : 6.65
Total cost (cents),	26.18
Manurial value obtainable,	9.48
Net cost,	16.70

II.

December 4 to December 23.

Wheat bran (pounds),	3.00
Maize feed,	3.00
Cotton-seed meal,	3.00
Sweet corn stover,*	14.56
Nutritive ratio,	1 : 4.61
Total cost (cents),	15.04
Manurial value obtainable,	7.29
Net cost,	7.75

III.

December 26 to January 13.

Wheat bran (pounds),	3.00
Maize feed,	3.00
Cotton-seed meal,	3.00
Dent corn stover,†	12.06
Nutritive ratio,	1 : 4.63
Total cost (cents),	14.42
Manurial value obtainable,	7.84
Net cost,	6.58

IV.

January 17 to February 23.

Wheat bran (pounds),	3.00
Maize feed,	3.00
Cotton-seed meal,	3.00
Hay,	5.00
Dent corn ensilage,	32.00
Nutritive ratio,	1 : 4.64
Total cost,	19.15
Manurial value obtainable,	8.46
Net cost,	10.69

V.

February 27 to March 23.

Wheat bran (pounds),	3.00
Maize feed,	3.00
Cotton-seed meal,	3.00
Hay,	5.00
Sweet corn ensilage,	41.39
Nutritive ratio,	1 : 4.80
Total cost (cents),	20.32
Manurial value obtainable,	8.60
Net cost,	11.72

* Stowell's Evergreen. † Pride of the North.

4. *Cost of Feed.*

The commercial valuation of the previously described daily average fodder rations during the five feeding periods of our experiment is based on the below-stated contemporary local price of the various fodder articles used in their composition : —

Local Market Cost per Ton of the Various Articles of Fodder used.

Corn meal,	$31 00
Wheat bran,	22 00
Maize feed,	25 00
Cotton-seed meal,	29 00
English hay,	15 00
Sweet corn stover,	5 00
Dent corn stover,	5 00
Sweet corn ensilage,	2 50
Dent corn ensilage,	2 50
Sugar beets,	5 00

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.				
	I.	II.	III.	IV.	V.
Total cost,	26.18	15.04	14.42	19.15	20.32
Manurial value obtainable,	9.48	7.29	7.84	8.46	8.60
Net cost,*	16.70	7.75	6.58	10.69	11.72

* Allowing eighty per cent. of the manurial value obtainable from the feed consumed.

Total cost of each daily ration represents the sum of the market cost of the quantity of the different fodder articles contained in that particular daily diet.

Net cost of a fodder article represents the cost of the article, less the commercial value of that portion of the various quantities of the different essential fertilizing constituents they contain which passes into the animal excretions, liquid and solid, and becomes thus available in the manurial refuse resulting from its consumption. The value of the manurial refuse obtainable from one and the same

kind and quality of fodder article depends on the function, the kind and the age of the animal which consumes it. In case of milch cows it is conceded that an allowance of a loss of twenty per cent. covers the amount of nitrogen, phosphoric acid and potash which passes into the milk produced, and is thus lost as a manurial resource of the farm.

As our various fodder articles quite frequently differ widely from each other with reference to the amount of nitrogen, phosphoric acid and potash they contain, it is but natural that the obtainable manurial value of our different fodder articles under otherwise corresponding circumstances must differ also more or less seriously. The more phosphoric acid, potash and in particular nitrogen a given quantity of a fodder article contains, the more valuable, considered from a commercial stand-point, is the manurial refuse resulting from its use. The subsequent abstract of our fertilizer analyses of the different fodder articles used on the present occasion may well serve as an illustration of the previous statements.

Commercial Valuation of Essential Constituents contained in the Various Articles of Fodder used.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

FERTILIZER ANALYSES.	Corn Meal.	Wheat Bran.	Maize Feed (Chicago).	Cotton-seed Meal.	English Hay.	Sweet Corn Stover.	Dent Corn Stover.	Sweet Corn Ensilage.	Dent Corn Ensilage.	Sugar Beets.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Moisture,	13.26	10.01	8.70	7.05	9.72	41.62	20.10	84.30	79.92	85.27
Nitrogen,	1.79	2.60	4.03	5.77	1.38	0.57	0.99	0.20	0.27	0.26
Phosphoric acid,	0.71	2.85	0.70	2.33	0.36	0.20	0.29	0.087	0.14	0.10
Potassium oxide,	0.44	1.63	0.43	1.72	1.57	1.00	1.40	0.41	0.33	0.48
Valuation per 2,000 pounds,	$6 55	$12 40	$13 25	$21 42	$5 95	$2 83	$4 55	$1 06	$1 26	$1 32
Per Ton of 2,000 Pounds.										
Market cost,	$31 00	$22 00	$25 00	$29 00	$15 00	$5 00	$5 00	$2 50	$2 50	$5 00
Manurial value obtainable,*	5 24	9 92	10 60	17 14	4 76	2 26	3 64	0 85	1 01	1 06
Net cost,	25 76	12 08	14 40	11 86	8 24	2 74	1 36	1 65	1 49	3 94

* Allowing a loss of twenty per cent. contained in the milk sold.

From previous discussions it will be noticed that the different fodder rations used during the five feeding periods of our last experiment varied seriously in regard to *market cost* as well as to *net cost*. To what particular circumstance this result is due deserves some special attention. Whether it is due to the cost of the grain feed or to that of the coarse feed, and to what extent in either case, is shown in the subsequent tabular statement.

Statement of the Cost of Fine and Coarse Feed Portion of the Daily Fodder Rations used.

Fine Feed.

[Cents.]

	Feeding Periods.				
	I.	II.	III.	IV.	V.
Total cost,	11.70	11.40	11.40	11.40	11.40
Manurial value obtainable,	3.90	5.65	5.65	5.65	5.65
Net cost,	7.80	5.75	5.75	5.75	5.75

Coarse Feed.

[Cents.]

	I.	II.	III.	IV.	V.
Total cost,	14.51	3.64	3.02	7.75	8.92
Manurial value obtainable,	5.65	1.65	2.20	3.30	3.45
Net cost,	8.86	1.99	0.82	4.45	5.47

The market cost of our grain feed ration is materially the same in all cases; the high manurial value of maize feed and cotton-seed meal (II., III., IV., V.), as compared with that of corn meal (I.), makes the net cost of the former two cents less than that of the latter. The pecuniary advantages arising from an intelligent use of corn stover and corn ensilage in the dairy industry, in place of English hay, deserve particular attention. In view of these results, it may not be out of place to repeat a former advice: —

"The high market price of two of our most prominent home-raised coarse fodder articles, first and second cut of upland meadow, English hay and rowen, affects seriously the degree of our financial results in the production of milk, as far as the cost of feed is concerned. We are in need of a cheaper source of supply of coarse fodder substances than

a considerable proportion of our grass lands, pastures and meadows, in their present state of productiveness, can claim to be. More satisfactory results can be obtained, no doubt, in many cases by turning indifferently yielding dry grass lands, if at all capable of higher cultivation, to account for the production of some other suitable fodder crops than grasses. The good services of dry fodder corn, corn stover and a good corn ensilage, for a more economical production of milk, are deservedly from day to day more generally recognized. However gratifying this fact will be considered, it is not advisable, in the light of past experience, in a general farm management to raise one fodder crop at the exclusion of all others, however lucrative at the time this practice may prove; such course can at best only offer a temporary relief. The introduction of a greater variety, in particular of annual reputed fodder crops, promises a more permanent improvement in fodder supply. Such course wherever adopted has not only resulted in cheapening the production of milk and beef, but has proved to be a most economical way to raise the general productiveness of farm lands to a higher standard."

Our local experience with a variety of annual leguminous fodder crops, as vetches, cow-peas, serradella and soja bean, has been very encouraging. The satisfactory results obtained in previous years are fully confirmed year after year. We are raising the present season vetch and oats, Canada peas and oats, soja beans and serradella, partly for green fodder and for ensilage, and partly for hay.

Quantity of Milk produced per Day (Quarts).

[One quart equals 2.15 pounds.]

	Feeding Periods.					General Average.	Extreme Variations.
	I.	II.	III.	IV.	V.		
Clarissa, .	7.18	5.76	4.88	4.52	–	5.59	3.72– 8.37
Cora, .	8.57	7.29	6.68	6.17	5.39	6.82	4.65– 9.77
Lucy, .	9.68	8.00	7.73	7.73	7.79	8.19	6.51–10.70
Gem, .	–	13.46	–	13.18	12.31	12.98	11.63–15.11

Considering the period of lactation in the case of each animal, the decline in yield of milk as the time of observation

advances seems to be normal. Cow No. 4, "Gem," was somewhat indisposed during the third feeding period, refusing for a week or two to eat her customary amount of feed; the yield of milk fell off, and is for this reason not recorded here. As soon as she began to consume again the regular fodder ration, the yield of milk with reference to quantity was normal; yet its quality had suffered a serious change in solids, as will be noticed from the following record of analyses of morning's milk: —

Analyses of Milk during Different Feeding Periods.

[Per Cent.]

1891-92.	Clarissa.		Cora.		Lucy.		Gem.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
Period II.: —								
December 8, .	15.12	5.96	14.06	5.17	13.68	4.66	–	–
December 15, .	13.96	5.15	13.39	4.34	12.81	4.77	13.93	4.91
December 22, .	15.50	5.61	13.65	4.73	13.67	4.67	14.49	5.10
Period III.: —								
December 29, .	14.09	5.02	13.03	4.37	13.63	4.43	13.19	4.16
January 5, .	13.95	4.62	13.21	4.21	14.14	5.05	–	–
January 12, .	14.55	4.72	14.01	4.66	13.53	4.38	–	–
Period IV.: —								
January 19, .	13.96	4.66	13.77	4.69	14.04	5.42	11.63	3.48
January 26, .	13.19	4.11	12.71	4.15	13.63	4.79	11.11	3.38
February 2, .	13.93	4.47	13.97	4.72	13.84	4.73	11.94	3.55
February 9, .	14.07	5.18	13.06	4.34	14.50	5.32	11.64	3.49
February 16, .	13.29	4.57	13.63	4.77	14.16	5.18	12.06	3.58
February 22, .	13.89	4.92	14.05	4.84	13.65	4.56	12.06	3.56
Period V.: —								
March 1, .	–	–	13.38	4.45	13.82	4.51	12.23	3.56
March 8, .	–	–	14.00	4.80	14.10	5.08	12.15	3.66
March 15, .	–	–	14.34	5.41	12.82	4.09	11.99	3.56
March 22, .	–	–	13.83	4.67	14.11	4.78	11.60	3.27

Live Weight of Animals during the Feeding Periods.

[Pounds]

	Feeding Periods.					Gain at Close.
	I.	II.	III.	IV.	V.	
Clarissa, ...	951	966	957	999	–	48
Cora, ...	1,062	1,042	1,051	1,062	1,069	7
Lucy, ...	850	815	816	808	804	—46
Gem, ...	–	869	–	856	865	—4

The general condition of the animals at the close of the observation was a satisfactory one.

Conclusions.

A careful consideration of the previously recorded results leads us to the following conclusions: —

1. The substitution of a ration composed of three pounds each of corn meal, maize feed and wheat bran, by one consisting of three pounds each maize feed, wheat bran and cotton-seed meal, *has in our case not materially changed the market cost of the grain feed ration, but reduced two cents its net cost, in consequence of the more valuable manurial refuse of the latter.*

2. The quantity and quality of milk has not been affected in any noticeable degree by the change in the grain feed ration in case of healthy animals.

3. The differences in the cost, *both market and net, of the different fodder rations, are in a controlling degree due to the cost of the different coarse fodder articles used, — a fact which has been repeatedly pointed out in previous communications.*

FEEDING RECORD.

Clarissa.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.										Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Maize Feed.	Cotton-seed Meal.	Hay.	Sweet Corn Stover.	Dent Corn Stover.	Sweet Corn Ensilage.	Dent Corn Ensilage.	Beets.					
1891-92.															
Nov. 8 to Nov. 23,	3.00	3.00	3.00	–	16.00	–	–	–	–	15.00	24.68	7.18	3.44	1:6.71	951
Dec. 4 to Dec. 23,	–	3.00	3.00	3.00	–	17.05	–	–	–	–	18.18	5.76	3.16	1:4.90	966
Dec. 26 to Jan. 13,	–	3.00	3.00	3.00	–	–	13.28	–	–	–	18.84	4.88	3.86	1:4.78	957
Jan. 17 to Feb. 23,	–	3.00	3.00	3.00	5.00	–	–	–	43.32	–	21.43	4.52	4.74	1:4.96	999

Cora.

FEEDING PERIODS.	Corn Meal.	Wheat Bran.	Maize Feed.	Cotton-seed Meal.	Hay.	Sweet Corn Stover.	Dent Corn Stover.	Sweet Corn Ensilage.	Dent Corn Ensilage.	Beets.	Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Nov. 8 to Nov. 23,	3.00	3.00	3.00	–	11.73	–	–	–	–	15.00	20.83	8.58	2.43	1:6.41	1,062
Dec. 4 to Dec 23,	–	3.00	3.00	3.00	–	12.32	–	–	–	–	15.42	7.29	2.11	1:4.38	1,042
Dec. 26 to Jan. 13,	–	3.00	3.00	3.00	–	–	9.78	–	–	–	16.04	6.68	2.40	1:4.35	1,051
Jan. 17 to Feb. 23,	–	3.00	3.00	3.00	5.00	–	–	–	26.65	–	18.09	6.17	2.93	1:4.49	1,062
Feb. 27 to Mar. 23,	–	3.00	3.00	3.00	5.00	–	–	34.56	–	–	18.17	5.39	3.37	1:4.64	1,069

FEEDING RECORD — *Concluded.*

Lucy.

Feeding Periods.	Feed consumed (Pounds) per Day.										Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Corn Meal.	Wheat Bran.	Maize Feed.	Cotton-seed Meal.	Hay.	Sweet Corn Stover.	Dent Corn Stover.	Sweet Corn Ensilage.	Dent Corn Ensilage.	Beets.					
1891-92.															
Nov. 8 to Nov. 23,	3.00	3.00	3.00	–	15.33	–	–	–	–	15.00	24.08	9.69	2.49	1:6.69	850
Dec. 4 to Dec. 23,	–	3.00	3.00	3.00	–	13.47	–	–	–	–	16.09	8.00	2.01	1:4.51	815
Dec. 26 to Jan. 13,	–	3.00	3.00	3.00	–	–	13.11	–	–	–	18.70	7.43	2.52	1:4.76	816
Jan. 17 to Feb. 23,	–	3.00	3.00	3.00	5.00	–	–	–	23.68	–	17.49	7.73	2.26	1:4.41	808
Feb. 27 to Mar. 23,	–	3.00	3.00	3.00	5.00	–	–	37.20	–	–	18.58	7.79	2.39	1:4.70	804

Gem.

Feeding Periods.	Corn Meal.	Wheat Bran.	Maize Feed.	Cotton-seed Meal.	Hay.	Sweet Corn Stover.	Dent Corn Stover.	Sweet Corn Ensilage.	Dent Corn Ensilage.	Beets.	Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Dec. 10 to Dec. 23,	–	3.00	3.00	3.00	–	15.39	–	–	–	–	17.21	13.46	1.27	1:4.71	869
Dec. 26 to Jan. 13,	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jan. 17 to Feb 23,	–	3.00	3.00	3.00	5.00	–	–	–	34.35	–	19.64	13.18	1.49	1:4.71	856
Feb. 27 to Mar. 23,	–	3.00	3.00	3.00	5.00	–	–	53.40	–	–	21.12	12.31	1.71	1:5.09	865

Total Cost of Feed per Quart of Milk.

Clarissa.

Feeding Periods.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Sweet Corn Stover consumed (Pounds).	Total Amount of Dent Corn Stover consumed (Pounds).	Total Amount of Sweet Corn Ensilage consumed (Pounds).	Total Amount of Dent Corn Ensilage consumed (Pounds).	Total Amount of Beets consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1891-92.														
Nov. 8 to Nov. 23, .	107.75	7.18	45.00	45.00	45.00	–	240.00	–	–	–	–	225.00	$4 11	3.81
Dec. 4 to Dec. 23, .	109.50	5.76	–	57.00	57.00	57.00	–	327.00	–	–	–	–	2 99	2.73
Dec. 26 to Jan. 13, .	87.84	4.88	–	54.00	54.00	54.00	–	–	239.00	–	–	–	2 65	3.02
Jan. 17 to Feb. 23, .	167.25	4.52	–	111.00	111.00	111.00	185.00	–	–	–	1,603.00	–	7 61	4.55

Cora.

Feeding Periods.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Sweet Corn Stover consumed (Pounds).	Total Amount of Dent Corn Stover consumed (Pounds).	Total Amount of Sweet Corn Ensilage consumed (Pounds).	Total Amount of Dent Corn Ensilage consumed (Pounds).	Total Amount of Beets consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
Nov. 8 to Nov. 23, .	128.70	8.58	45.00	45.00	45.00	–	176.00	–	–	–	–	225.00	$3 63	2.82
Dec. 4 to Dec. 23, .	138.50	7.29	–	57.00	57.00	57.00	–	234.00	–	–	–	–	2 76	1.99
Dec. 26 to Jan. 13, .	120.25	6.68	–	54.00	54.00	54.00	–	–	176.00	–	–	–	2 49	2.07
Jan. 17 to Feb. 23, .	228.29	6.17	–	111.00	111.00	111.00	185.00	–	–	–	986.00	–	6 84	2.99
Feb. 27 to Mar. 23, .	134.75	5.39	–	75.00	75.00	75.00	125.00	–	–	864.00	–	–	4 87	3.61

TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

Lucy.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Sweet Corn Stover consumed (Pounds).	Total Amount of Dent Corn Stover consumed (Pounds).	Total Amount of Sweet Corn Ensilage consumed (Pounds).	Total Amount of Dent Corn Ensilage consumed (Pounds).	Total Amount of Beets consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed to Production of One Quart of Milk (Cents).
1891-92.														
Nov. 8 to Nov. 23, .	145.35	9.69	45.00	45.00	45.00	–	230.00	–	–	–	–	225.00	$4 05	2.78
Dec. 4 to Dec. 23, .	152.00	8.00	–	57.00	57.00	57.00	–	256.00	–	–	–	–	2 81	1.85
Dec. 26 to Jan. 13, .	133.74	7.43	–	54.00	54.00	54.00	–	–	236.00	–	–	–	2 64	1.98
Jan. 17 to Feb. 23, .	286.00	7.73	–	111.00	111.00	111.00	185.00	–	–	–	876.00	–	6 71	2.35
Feb. 27 to Mar. 23, .	194.75	7.79	–	75.00	75.00	75.00	125.00	–	–	930.00	–	–	4 95	2.54

Gem.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Hay consumed (Pounds).	Total Amount of Sweet Corn Stover consumed (Pounds).	Total Amount of Dent Corn Stover consumed (Pounds).	Total Amount of Sweet Corn Ensilage consumed (Pounds).	Total Amount of Dent Corn Ensilage consumed (Pounds).	Total Amount of Beets consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed to Production of One Quart of Milk (Cents).
Dec. 10 to Dec. 23, .	174.98	13.46	–	39.00	39.00	39.00	–	200.07	–	–	–	–	$1 98	1.13
Dec. 26 to Jan. 13, .	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Jan. 17 to Feb. 23, .	487.66	13.18	–	111.00	111.00	111.00	185.00	–	–	–	1,270.95	–	7 20	1.48
Feb. 27 to Mar. 23, .	307.75	12.31	–	75.00	75.00	75.00	125.00	–	–	1,335.00	–	–	5 46	1.77

2. Summer Feeding Experiments with Milch Cows.

May, 1892, to September, 1892.

[Green feed: rye, Canada peas and oats, summer vetch and oats, fodder corn and serradella; grain feed: wheat bran, Buffalo gluten feed and cotton-seed meal.]

The experiment was instituted for the same purpose as our summer feeding experiments with milch cows in preceding years (since 1887). The main object of these experiments was to ascertain the fitness of a series of more or less reputed annual fodder crops to serve as the main coarse fodder supply for dairy cows during the growing season (June to October). Their selection as well as their mode of cultivation was largely governed by their special adaptation to the soil and to the period of season when needed to serve as green fodder.

The results obtained in previous years with vetch and oats, soja bean, Southern cow-pea and serradella have been already published. A larger number of different kinds of annual fodder crops have been cultivated during the past season than in preceding ones.

The whole season was divided into four feeding periods, as far as the green coarse fodder articles are concerned, namely, rye, peas and oats, vetch and oats, and fodder corn and serradella. The feeding of the rye and of the oats began when heading out; that of the peas, vetch and serradella when fairly in bloom; while that of the fodder corn began when the kernels commenced glazing.

One-fourth of a daily ration of rowen (second cut of upland meadows), five pounds, was fed in every instance, in common with the temporary green fodder ration.

The amount of rowen and of grain feed fed per day remained the same throughout the entire season. The daily consumption of the green fodder was governed by the individual appetite of the animal, and usually decreased with the advancing growth of the fodder plant.

The feeding of the green crops ceased as soon as they neared maturing. The part of the fodder crops which was

left unconsumed was cut and either turned into hay or placed in silos (see farther on for details under field experiments).

The grain feed ration remained the same throughout the entire season, Buffalo gluten feed, wheat bran and cotton-seed meal, three pounds of each daily per animal.

The cows used were, as has been the case in all our previous observations, grades of various descriptions and of a similar general character as on those occasions.

History of Cows.

Name of Cow.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at Beginning of Trial (Quarts).	Number of Months on Trial.
May,	Native,	*	Jan. 15, 1892,	11.71	6
Gem,	Grade Shorthorn,	5	Dec. 6, 1891,	13.53	6
Lucy,	Grade Ayrshire,	7	June 2, 1891,	10.88	6
Viola,	Native,	*	Feb. 10, 1892,	13.09	6
Anna,	Native,	*	Jan. 26, 1892,	11.94	6
Florence,	Grade Shorthorn,	*	May 13, 1892,	11.78	3½

The general management of this feeding experiment was the same as on preceding occasions.

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$20 00
Gluten feed (Buffalo),	23 00
Cotton-seed meal,	28 00
Rowen,	15 00
Sugar beets,	5 00
Green rye,	2 50
Canada peas and oats (green),	2 75
Vetch and oats (green),	2 75
Corn fodder (green),	2 50
Serradella,	2 75

* Unknown.

Analyses of Fine Feed used.

[Grain Feed.]

FOOD ANALYSES.	Wheat Bran.	Gluten Feed.	Cotton-seed Meal.
Moisture at 100° C.,	10.01	6.33	7.05
Dry matter,	89.99	93.67	92.95
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	6.58	0.95	5.40
" cellulose,	11.77	5.76	6.15
" fat,	5.04	12.99	13.82
" protein,	18.06	25.75	38.79
Non-nitrogenous extract matter,	58.55	54.55	35.84
	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran.	Gluten Feed.	Cotton-seed Meal.
Moisture,	10.01	6.33	7.05
Nitrogen,	2.60	3.86	5.77
Phosphoric acid,	2.85	0.207	2.33
Potassium oxide,	1.63	0.04	1.72
Valuation per 2,000 pounds,	$12 40	$11 85	$21 42

Analyses of Coarse Fodder Articles used.

FOOD ANALYSES.	Rowen.	Sugar Beets.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Corn Fodder.	Serradella.
Moisture at 100° C., .	13.90	85.27	62.11	86.32	82.02	68.53	82.03
Dry matter, . .	86.10	14.73	37.89	13.68	17.98	31.47	17.97
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash, . . .	8.28	5.95	5.27	6.90	9.31	5.68	9.59
" cellulose,. .	28.88	6.49	21.52	26.66	29.80	22.99	26.28
" fat, . . .	3.91	0.66	2.46	2.29	2.79	2.81	2.59
" protein, . .	13.45	10.97	5.38	16.01	16.77	6.22	15.13
Non-nitrogenous extract matter, . .	45.48	75.93	65.37	48.14	41.33	62.30	46.41
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

FERTILIZER ANALYSES.	Rowen.	Sugar Beets.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Corn Fodder.	Serradella.
Moisture, . . .	13.90	85.27	62.11	86.32	82.02	68.53	82.03
Nitrogen, . . .	1.853	0.26	0.327	0.350	0.482	0.310	0.435
Phosphoric acid, .	0.464	0.10	0.150	0.130	0.132	0.055	0.126
Potassium oxide, .	1.966	0.48	0.734	0.415	0.418	0.149	0.379
Valuation per 2,000 pounds, . . .	$7 84	$1 32	$1 80	$1 56	$1 97	$1 12	$1 78

Average Composition of the Daily Fodder Rations used during the Five Successive Feeding Periods (1892).

I.		II.	
April 1 to May 21.		*May 27 to June 13.*	
Wheat bran (pounds),	3.00	Wheat bran (pounds),	3.00
Gluten feed (Buffalo),	3.00	Gluten feed (Buffalo),	3.00
Cotton-seed meal,	3.00	Cotton-seed meal,	3.00
Rowen,	5.00	Rowen,	5.00
Sugar beets,	15.00	Green rye,	16.22
Nutritive ratio,	1 : 4.48	Nutritive ratio,	1 : 4.82
Total cost (cents),	25.66	Total cost (cents),	16.43
Manurial value obtainable,	10.95	Manurial value obtainable,	8.21
Net cost,	14.71	Net cost,	8.22

III.		IV.	
June 18 to June 28.		*July 4 to August 3.*	
Wheat bran (pounds),	3.00	Wheat bran (pounds),	3.00
Gluten feed (Buffalo),	3.00	Gluten feed (Buffalo),	3.00
Cotton-seed meal,	3.00	Cotton-seed meal,	3.00
Rowen,	5.00	Rowen,	5.00
Canada peas and oats,	27.50	Vetch and oats,	37.71
Nutritive ratio,	1 : 3.78	Nutritive ratio,	1 : 3.75
Total cost (cents),	18.16	Total cost (cents),	19.57
Manurial value obtainable,	8.75	Manurial value obtainable,	10.02
Net cost,	9.41	Net cost,	9.55

V.	
September 17 to September 27.	
Wheat bran (pounds),	3.00
Gluten feed (Buffalo),	3.00
Cotton-seed meal,	3.00
Rowen,	5.00
Corn fodder,	30.00
Serradella,	20.00
Nutritive ratio,	1 : 5.52
Total cost (cents),	20.90
Manurial value obtainable,	9.81
Net cost,	11.09

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.				
	I.	II.	III.	IV.	V.
Total cost,	25.66	16.43	18.16	19.57	20.90
Manurial value obtainable,	10.95	8.21	8.75	10.02	9.81
Net cost,*	14.71	8.22	9.41	9.55	11.09

* Allowing eighty per cent. of the manurial value of the feed consumed obtainable.

The local market cost of the daily grain feed ration is the same in all stated cases, 11.1 cents; while that of the daily coarse feed ration varies, 5.12 to 14.56 cents (see I. and II. periods). The obtainable manurial value varies from two-fifths to one-half of the total cost of the fodder ration.

Quantity of Milk produced per Day (Quarts).

[One quart equals 2.15 pounds.]

	Feeding Periods.					General Average.	Extreme Variations.
	I.	II.	III.	IV.	V.		
May,	11.71	9.19	9.76	8.54	7.27	9.29	6.05–13.72
Gem,	13.53	11.53	11.34	11.21	11.21	11.76	9.53–16.28
Lucy,	10.88	8.27	9.44	8.98	8.22	9.16	6.74–12.54
Viola,	13.09	9.97	10.22	9.24	7.21	9.95	6.40–14.48
Anna,	11.94	9.19	9.79	8.33	6.94	9.24	6.51–13.14
Florence,	–	–	11.78	11.12	10.56	11.15	9.77–13.95

Cost of Feed per Quart of Milk.

[Cents.]

	Feeding Periods.					General Average.
	I.	II.	III.	IV.	V.	
May,	2.19	1.80	1.86	2.28	2.88	2.20
Gem,	1.89	1.45	1.61	1.75	1.87	1.71
Lucy,	2.36	2.02	1.93	2.19	2.54	2.21
Viola,	1.96	1.62	1.78	2.12	2.90	2.08
Anna,	2.15	1.76	1.86	2.35	3.01	2.02
Florence,	–	–	1.55	1.76	1.98	1.76

Analyses of Milk during Different Feeding Periods.

[Per Cent.]

1892.	May.		Gem.		Lucy.		Viola.		Anna.		Florence.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
Period I.: —												
April 19, ...	13.70	4.34	12.75	3.93	14.28	4.85	13.24	4.10	11.47	2.80	–	–
May 3, ...	12.96	3.91	12.20	3.61	13.60	4.51	12.50	3.71	10.71	2.73	–	–
May 17, ...	14.33	4.38	12.84	3.81	14.44	4.51	14.19	4.64	12.30	3.45	–	–
Period II.: —												
June 7, ...	15.08	4.90	13.30	4.04	14.45	4.82	14.07	4.61	12.67	3.55	12.07	3.34
Period III.: —												
June 28, ...	14.57	5.25	12.30	4.59	13.66	3.60	14.03	5.23	12.61	3.86	12.36	3.60
Period IV.: —												
July 12, ...	12.98	3.56	12.80	3.76	13.91	4.58	13.30	4.29	11.45	2.83	12.03	3.51
July 19, ...	12.55	2.92	12.86	3.75	14.18	4.92	12.69	3.70	11.33	2.42	12.17	3.16
July 29, ...	13.75	4.54	12.73	3.31	13.86	4.59	13.08	4.03	12.14	3.20	12.74	4.16

No analysis was made of the milk during the fifth feeding period.

Conclusion.

The results of our summer feeding experiments are on the whole very satisfactory, as may be seen from the summary of the yield of milk and of the cost of feed consumed per quart of milk produced. They furnish also an additional illustration of the statement that a well-regulated system of feeding our dairy stock during the summer secures the most satisfactory results, financially and otherwise.

FEEDING RECORD.

May.

FEEDING PERIODS.	Feed consumed (Pounds) per Day										Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Gluten Feed.	Cotton-seed Meal.	Rowen.	Sugar Beets.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Corn Stover.	Serradella.					
1892.															
April 1 to May 21, .	3.00	3.00	3.00	15.00	15.00	–	–	–	–	–	23.43	11.71	2.00	1:4.48	888
May 27 to June 13, .	3.00	3.00	3.00	5.00	–	16.76	–	–	–	–	18.95	9.19	2.06	1:4.82	834
June 18 to June 28, .	3.00	3.00	3.00	5.00	–	–	27.50	–	–	–	16.36	9.76	1.68	1:3.78	845
July 4 to Aug. 3, .	3.00	3.00	3.00	5.00	–	–	–	37.07	–	–	19.27	8.54	2.26	1:3.70	853
Sept. 17 to Sept. 27, .	3.00	3.00	3.00	5.00	–	–	–	–	30.00	20.00	25.63	7.27	3.52	1:5.22	930

Gem.

FEEDING PERIODS.	Wheat Bran.	Gluten Feed.	Cotton-seed Meal.	Rowen.	Sugar Beets.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Corn Stover.	Serradella.	Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
April 1 to May 21, .	3.00	3.00	3.00	15.00	15.00	–	–	–	–	–	23.43	13.53	1.73	1:4.48	829
May 27 to June 13, .	3.00	3.00	3.00	5.00	–	18.23	–	–	–	–	19.51	11.53	1.69	1:4.83	865
June 18 to June 28, .	3.00	3.00	3.00	5.00	–	–	27.50	–	–	–	16.36	11.34	1.44	1:3.78	847
July 4 to Aug. 3, .	3.00	3.00	3.00	5.00	–	–	–	38.00	–	–	19.43	11.21	1.64	1:3.76	859
Sept. 17 to Sept. 27, .	3.00	3.00	3.00	5.00	–	–	–	–	30.00	20.00	25.63	11.21	2.28	1:5.22	900

FEEDING RECORD — *Concluded.*

Lucy.

Feeding Periods.	Feed consumed (Pounds) per Day. Wheat Bran.	Gluten Feed.	Cotton-seed Meal.	Rowen.	Sugar Beets.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Corn Fodder.	Serradella.	Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
1892.															
April 1 to May 21,	3.00	3.00	3.00	15.00	15.00	–	–	–	–	–	23.43	10.88	2.15	1:4.48	817
May 27 to June 13,	3.00	3.00	3.00	5.00	–	18.23	–	–	–	–	19.51	8.27	2.36	1:4.83	821
June 18 to June 28,	3.00	3.00	3.00	5.00	–	–	27.50	–	–	–	16.36	9.44	1.73	1:3.78	795
July 4 to Aug. 3,	3.00	3.00	3.00	5.00	–	–	–	38.00	–	–	19.43	8.98	2.16	1:3.76	821
Sept. 17 to Sept. 27,	3.00	3.00	3.00	5.00	–	–	–	–	30.00	20.00	25.63	8.22	3.12	1:5.22	840

Viola.

Feeding Periods.	Wheat Bran.	Gluten Feed.	Cotton-seed Meal.	Rowen.	Sugar Beets.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Corn Fodder.	Serradella.	Total Amount of Dry Matter consumed per Day (Pounds).	Quarts of Milk produced per Day.	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
April 1 to May 21,	3.00	3.00	3.00	15.00	15.00	–	–	–	–	–	23.43	13.09	1.78	1:4.48	916
May 27 to June 13,	3.00	3.00	3.00	5.00	–	13.94	–	–	–	–	17.88	9.97	1.79	1:4.80	875
June 18 to June 28,	3.00	3.00	3.00	5.00	–	–	27.50	–	–	–	16.36	10.22	1.60	1:3.78	875
July 4 to Aug. 3,	3.00	3.00	3.00	5.00	–	–	–	38.00	–	–	19.43	9.24	2.10	1:3.76	886
Sept. 17 to Sept. 27,	3.00	3.00	3.00	5.00	–	–	–	–	30.00	20.00	25.63	7.21	3.55	1:5.22	925

Anna.

April 1 to May 21, .	3.00	3.00	3.00	15.00	15.00	-	-	-	-	-	23.43	11.94	1.97	1:4.48	969
May 27 to June 23, .	3.00	3.00	3.00	5.00	-	13.94	-	-	-	-	17.88	9.19	1.94	1:4.80	935
June 18 to June 28, .	3.00	3.00	3.00	5.00	-	-	27.50	-	-	-	16.36	9.79	1.67	1:3.78	945
July 4 to Aug. 3, .	3.00	3.00	3.00	5.00	-	-	-	37.60	-	-	19.36	8.33	2.08	1:3.75	947
Sept. 17 to Sept. 27, .	3.00	3.00	3.00	5.00	-	-	-	-	30.00	20.00	25.63	6.94	3.70	1:5.22	987

Florence.

June 18 to June 28, .	3.00	3.00	3.00	5.00	-	-	27.50	-	-	-	16.36	11.78	1.39	1:3.78	881
July 4 to Aug. 3, .	3.00	3.00	3.00	5.00	-	-	-	37.60	-	-	19.36	11.12	1.74	1:3.75	938
Sept. 17 to Sept. 27, .	3.00	3.00	3.00	5.00	-	-	-	-	30.00	20.00	25.63	10.56	2.43	1:5.22	935

TOTAL COST OF FEED PER QUART OF MILK.

May.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Feed consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Green Rye consumed (Pounds).	Total Amount of Canada Peas and Oats consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Serradella consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
1892.														
April 1 to May 21,	585.47	11.71	150.00	150.00	150.00	750.00	750.00	–	–	–	–	–	$12 83	2.19
May 27 to June 13,	156.16	9.19	51.00	51.00	51.00	85.00	–	285.00	–	–	–	–	2 81	1.80
June 18 to June 28,	97.56	9.76	30.00	30.00	30.00	50.00	–	–	275.00	–	–	–	1 82	1.86
July 4 to Aug. 3,	256.05	8.54	90.00	90.00	90.00	150.00	–	–	–	1112.00	–	–	5 84	2.28
Sept. 17 to Sept. 27,	72.67	7.27	30.00	30.00	30.00	50.00	–	–	–	–	300.00	200.00	2 09	2.88

Gem.

FEEDING PERIODS.	Total Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Gluten Feed consumed (Pounds).	Total Amount of Cotton-seed Meal consumed (Pounds).	Total Amount of Rowen consumed (Pounds).	Total Amount of Sugar Beets consumed (Pounds).	Total Amount of Green Rye consumed (Pounds).	Total Amount of Canada Peas and Oats consumed (Pounds).	Total Amount of Vetch and Oats consumed (Pounds).	Total Amount of Corn Fodder consumed (Pounds).	Total Amount of Serradella consumed (Pounds).	Total Cost of Feed consumed.	Average Cost of Feed for Production of One Quart of Milk (Cents).
April 1 to May 21,	676.28	13.53	150.00	150.00	150.00	750.00	750.00	–	–	–	–	–	$12 83	1.89
May 27 to June 13,	196.05	11.53	51.00	51.00	51.00	85.00	–	310.00	–	–	–	–	2 84	1.45
June 18 to June 28,	113.37	11.34	30.00	30.00	30.00	50.00	–	–	275.00	–	–	–	1 82	1.61
July 4 to Aug. 3,	336.16	11.21	90.00	90.00	90.00	150.00	–	–	–	1140.00	–	–	5 88	1.75
Sept. 17 to Sept. 27,	112.09	11.21	30.00	30.00	30.00	50.00	–	–	–	–	300.00	200.00	2 09	1.87

							Lucy.							
April 1 to May 21,	543.95	10.88	150.00	150.00	150.00	750.00	750.00	–	–	–	–	–	$12 83	2.36
May 21 to June 13,	140.58	8.27	51.00	51.00	51.00	85.00	–	310.00	–	–	–	–	2 84	2.02
June 18 to June 28,	94.42	9.44	30.00	30.00	30.00	50.00	–	–	275.00	–	–	–	1 82	1.93
July 4 to Aug. 3,	269.30	8.98	90.00	90.00	90.00	150.00	–	–	–	1140.00	–	–	5 88	2.19
Sept 17 to Sept. 27,	82.21	8.22	30.00	30.00	30.00	50.00	–	–	–	–	300.00	200.00	2 09	2.54
							Viola.							
April 1 to May 21,	654.65	13.09	150.00	150.00	150.00	750.00	750.00	–	–	–	–	–	$12 83	1.96
May 27 to June 13,	169.42	9.97	51.00	51.00	51.00	85.00	–	237.00	–	–	–	–	2 75	1.62
June 18 to June 28,	102.21	10.22	30.00	30.00	30.00	50.00	–	–	275.00	–	–	–	1 82	1.78
July 4 to Aug. 3,	277.21	9.24	90.00	90.00	90.00	150.00	–	–	–	1140.00	–	–	5 88	2.12
Sept. 17 to Sept 27,	72.09	7.21	30.00	30.00	30.00	50.00	–	–	–	–	300.00	200.00	2 09	2.90
							Anna.							
April 1 to May 21,	597.09	11.94	150.00	150.00	150.00	750.00	750.00	–	–	–	–	–	$12 83	2.15
May 27 to June 13,	156.28	9.19	51.00	51.00	51.00	85.00	–	237.00	–	–	–	–	2 75	1.76
June 18 to June 28,	97.90	9.79	30.00	30.00	30.00	50.00	–	–	275.00	–	–	–	1 82	1.86
July 4 to Aug. 3,	249.88	8.33	90.00	90.00	90.00	150.00	–	–	–	1128.00	–	–	5 87	2.35
Sept. 17 to Sept. 27,	69.42	6.94	30.00	30.00	30.00	50.00	–	–	–	–	300.00	200.00	2 09	3.01
							Florence.							
June 18 to June 28,	117.79	11.78	30.00	30.00	30.00	50.00	–	–	275.00	–	–	–	$1 82	1.55
July 4 to Aug. 3,	333.60	11.12	90.00	90.00	90.00	150.00	–	–	–	1128.00	–	–	5 87	1.76
Sept 17 to Sept. 27,	105.58	10.56	30.00	30.00	30.00	50.00	–	–	–	–	300.00	200.00	2 09	1.98

3. Creamery Record of the Station for 1891 and 1892.

The cost of feed consumed is based on the market price as stated in the subsequent table. The valuation of the whole milk is taken at three cents per quart. The estimates of the value of fertilizing ingredients contained in the feed are based on those given in the following table : —

Local Market Cost per Ton of the Various Articles of Fodder used.

Corn meal,	$29 50
Wheat bran (in 1891, $24),	20 00
Gluten meal,	27 50
Gluten feed,	23 00
Maize feed,	25 00
Old-process linseed meal,	26 00
Cotton-seed meal,	28 00
Brewers' grain,	23 00
Hay,	15 00
Rowen,	15 00
Green fodder corn,	2 50
Corn stover,	5 00
Corn ensilage,	2 50
Corn and soja bean ensilage,	3 50
Green rye,	2 50
Soja bean (green),	4 40
Canada peas and oats (green),	2 75
Vetch (green),	2 75
Vetch and oats (green),	2 75
Rape,	2 50
Serradella,	2 75
Sugar beets,	5 00
Cabbages,	2 50

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per 2,000 Pounds.
Corn meal,	1.79	0.71	0.44	$6 55
Wheat bran,	2.60	2.85	1.63	12 40
Gluten meal,	5.22	0.40	0.05	16 15
Gluten feed,	3.86	2.07	0.04	13 89
Maize feed,	4.03	0.70	0.43	13 25
Old-process linseed meal,	5.33	1.64	1.16	18 84
Cotton-seed meal,	5.77	2.33	1.72	21 42
Brewers' grain,	3.299	1.192	1.466	12 53
Hay,	1.38	0.36	1.57	5 95
Rowen,	1.853	0.464	1.966	7 84
Green fodder corn,	0.31	0.055	0.149	1 12
Corn stover,	0.78	0.245	1.20	3 70
Corn ensilage,	0.235	0.113	0.37	1 16
Corn and soja bean ensilage,	0.708	0.42	0.444	2 99
Green rye,	0.327	0.15	0.734	1 80
Soja beans (green),	0.59	0.193	0.311	2 26
Canada peas and oats (green),	0.35	0.128	0.402	1 55
Vetch (green),	0.49	0.133	0.425	2 00
Vetch and oats (green),	0.482	0.132	0.418	1 97
Rape,	0.46	0.12	0.35	1 82
Serradella,	0.435	0.126	0.379	1 78
Sugar beets,	0.26	0.10	0.48	1 32
Cabbages,	0.30	0.11	0.43	1 41

The value of cream is that granted us from month to month by our local creamery association. The station has no other connection with the financial management of the creamery.

Our presentation of financial results is based on the local cost of feed alone, and does not consider interest on investment and labor involved, for the reason that approximate estimates on these points are in an exceptional degree dependent on quality of stock and varying local circumstances. The details are embodied in a few subsequent tables under the following headings: —

1. Statement of articles of fodder used.
2. Record of average quality of milk and fodder rations.
3. Value of cream at creamery basis of valuation.
4. Cost of skim-milk at the selling price of three cents per quart of whole milk.
5. Fertilizing constituents of cream.
6. Some conclusions suggested by the records.
7. Analyses of cream.
8. Average milk analyses for previous years.

1. *Statement of Articles of Fodder used during 1891 (Pounds).*

1891.	Corn Meal.	Wheat Bran.	Gluten Meal.	Maize Feed.	Old-process Linseed Meal.	Cotton-seed Meal.	Brewers' Grain.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Mixed Ensilage.	Vetch and Oats.	Soja Beans.	Sugar Beets.	Cabbages.
January,	541.50	541.50	-	-	244.50	297.00	-	-	2,355.00	-	-	1,614.00	-	-	840.00	-
February,	504.00	504.00	306.00	-	-	198.00	-	-	857.00	-	-	7,566.00	-	-	-	-
March,	558.00	558.00	450.00	-	-	108.00	-	-	169.00	-	2,153.50	1,269.00	-	-	-	-
April,	537.00	540.00	-	-	-	534.00	-	-	1,915.50	-	106.50	-	-	-	-	-
May,	558.00	558.00	450.00	-	-	108.00	-	-	3,295.00	-	-	-	-	-	-	-
June,	516.00	540.00	516.00	-	-	-	-	-	2,417.50	-	-	-	-	-	-	-
July,	555.00	180.00	555.00	-	-	-	378.00	-	1,052.00	-	-	-	7,285.00	-	-	-
August,	558.00	324.00	558.00	-	-	-	234.00	-	1,032.50	-	-	-	479.00	6,965.00	-	1,820.00
September,	540.00	-	540.00	-	-	-	540.00	-	690.00	4,504.50	-	-	-	1,011.00	-	1,800.00
October,	558.00	-	222.00	-	-	-	558.00	2,673.00	-	-	-	-	-	-	680.00	1,560.00
November,	546.00	423.00	-	442.00	-	18.00	141.00	2,588.00	-	-	-	-	-	-	2,610.00	-
December,	-	555.00	-	555.00	-	549.00	-	102.00	-	-	2,676.00	-	-	-	-	-

1. Statement of Articles of Fodder used during 1892 (Pounds).

1892.	Wheat Bran.	Gluten Feed.	Maize Feed.	Cotton-seed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Green Rye.	Canada Peas and Oats.	Vetch.	Vetch and Oats.	Rape.	Serradella.	Sugar Beets.	Cabbages.
January, . .	523.50	-	523.50	523.50	570.00	-	-	714.00	3,768.00	-	-	-	-	-	-	-	-
February, .	516.00	-	516.00	516.00	870.00	-	-	-	6,292.00	-	-	-	-	-	-	-	-
March, . .	549.00	150.00	396.00	549.00	870.00	615.00	-	-	4,604.00	-	-	-	-	-	-	840.00	-
April, . .	450.00	450.00	-	450.00	-	2,250.00	-	-	-	-	-	-	-	-	-	2,250.00	-
May, . . .	465.00	465.00	-	465.00	-	1,855.00	-	-	-	850.00	-	-	-	-	-	1,500.00	-
June, . .	540.00	540.00	-	540.00	-	900.00	-	-	-	1,254.00	2,220.00	-	540.00	-	-	-	-
July, . .	558.00	558.00	-	558.00	-	930.00	-	-	-	-	-	-	6,776.00	-	-	-	-
August, . .	558.00	558.00	-	558.00	-	930.00	6,102.00	-	-	-	-	1,380.00	-	882.00	-	-	2,016.00
September, .	540.00	540.00	-	540.00	-	900.00	7,781.00	-	-	-	-	-	-	297.00	2,130.00	-	-
October, . .	558.00	558.00	-	558.00	-	270.00	1,119.00	-	-	-	-	-	-	162.00	1,008.00	-	180.00

2. *Record of Average Quality of Milk and of Fodder Rations (1891).*

1891.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	Feed consumed (Pounds) per Day. Corn Meal	Wheat Bran.	Gluten Meal.	Maize Feed.	Old-process Linseed Meal.	Cotton-seed Meal.	Brewers' Grain.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja Bean Ensilage.	Vetch and Oats.	Soja Beans.	Sugar Beets.
January,	14.99	5.19	1.54	1:4.83	3.00	3.00	-	-	3.00	-	-	-	18.00	-	-	-	-	-	-
				1:4.17	3.00	3.00	-	-	-	3.00	-	-	5.00	-	-	42.00	-	-	-
February,	14.71	5.09	1.76	1:4.17	3.00	3.00	-	-	-	3.00	-	-	5.00	-	-	42.00	-	-	-
				1:4.70	3.00	3.00	3.00	-	-	-	-	-	5.00	-	-	46.00	-	-	-
March,	14.82	5.00	1.62	1:6.74	3.00	3.00	3.00	-	-	-	-	-	-	-	14.00	-	-	-	-
April,	14.41	5.21	1.53	1:5.66	3.00	3.00	-	-	-	3.00	-	-	-	-	14.00	-	-	-	-
				1:4.49	3.00	3.00	-	-	-	3.00	-	-	18.00	-	-	-	-	-	-
May,	13.75	4.39	1.67	1:5.14	3.00	3.00	3.00	-	-	-	-	-	18.00	-	-	-	-	-	-
June,	-	-	1.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July,	13.41	4.18	1.78	1:6.17	3.00	-	3.00	-	-	-	3.00	-	5.00	-	-	-	47.00	-	-
August,	13.42	4.22	1.86	1:5.07	3.00	3.00	3.00	-	-	-	3.00	-	5.00	-	-	-	-	51.00	-
				1:4.76	3.00	-	3.00	-	-	-	-	-	5.00	-	-	-	-	47.00	-
September,	13.90	4.15	1.75	1:6.17	3.00	-	3.00	-	-	-	3.00	-	5.00	39.00	-	-	-	-	-
October,	14.52	4.63	1.72	1:5.79	3.00	-	3.00	-	-	-	3.00	16.00	-	-	-	-	-	-	-
				1:5.34	3.00	-	-	-	-	3.00	3.00	13.90	-	-	-	-	-	-	15.00
November,	-	-	1.76	1:6.65	3.00	3.00	-	3.00	-	-	-	14.35	-	-	-	-	-	-	15.00
December,	14.42	4.98	1.70	1:4.61	-	3.00	-	3.00	-	3.00	-	-	-	-	14.56	-	-	-	-
Averages,	14.24	4.70	1.73	1:5.28															

2. *Record of Average Quality of Milk and of Fodder Rations (1892).*

1892.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	FEED CONSUMED (POUNDS) PER DAY. Wheat Bran.	Gluten Feed.	Maize Feed.	Cotton-seed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Serradella.	Sugar Beets.
January,	13.75	4.55	1.73	1:4.63 –	3.00 3.00	– –	3.00 3.00	3.00 3.00	– 5.00	– –	– –	12.06 –	– 32.00	– –	– –	– –	– –	– –
February,	13.24	4.36	1.70	1:4.64	3.00	–	3.00	3.00	5.00	–	–	–	32.00	–	–	–	–	–
March,	12.98	4.10	1.58	1:4.81	3.00	–	3.00	3.00	5.00	–	–	–	41.39	–	–	–	–	–
April,	13.09	4.01	1.72	1:4.48	3.00	3.00	–	3.00	–	15.00	–	–	–	–	–	–	–	15.00
May,	13.00	3.92	1.77	1:4.80	3.00	3.00	–	3.00	–	15.00	–	–	–	–	–	–	–	15.00
June,	13.43	4.28	2.09	1:3.78 1:3.70	3.00 3.00	3.00 3.00	– –	3.00 3.00	– –	5.00 5.00	– –	– –	– –	16.22 –	– 27.50	– –	– –	– –
July,	12.80	3.73	1.82	1:3.76	3.00	3.00	–	3.00	–	5.00	–	–	–	–	–	37.71	–	–
August,	12.30	3.50	2.08	1:5.00	3.00	3.00	–	3.00	–	5.00	50.00	–	–	–	–	–	–	–
September,	12.55	3.66	1.88	1:5.70 1:4.60	3.00 3.00	3.00 3.00	– –	3.00 3.00	– –	5.00 5.00	70.00 30.00	– –	– –	– –	– –	– –	– 20.00	– –
October,	13.17	3.77	1.85	1:5.22	3.00	3.00	–	3.00	–	–	30.00	–	–	–	–	–	20.00	–
Averages,	13.44	4.42	1.82	1:4.60														

3. Value of Cream at Creamery Basis of Valuation.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1891.					
January,	$42 88	$22 85	$0 60	$20 63	$35 23
February,	40 03	24 02	0 61	16 62	35 49
March,	31 38	16 71	0 69	15 36	42 44
April,	35 25	17 52	0 63	18 36	37 36
May,	47 34	22 98	0 74	25 10	40 82
June,	39 32	18 71	0 68	21 29	32 40
July,	40 50	20 20	0 66	20 96	32 26
August,	48 47	20 17	0 68	28 98	36 26
September,	36 88	16 16	0 68	21 40	41 84
October,	41 39	16 62	0 63	25 40	39 48
November,	46 47	17 83	0 52	29 16	32 12
December,	28 75	18 25	0 51	9 93	31 60
Averages,	$39 89	$19 33	$0 64	$21 10	$36 44
1892.					
January,	$31 07	$17 51	$0 55	$14 11	$34 64
February,	34 38	18 36	0 62	16 64	38 95
March,	38 50	20 95	0 76	18 31	45 04
April,	38 47	21 04	0 65	18 08	36 59
May,	35 23	20 13	0 67	15 77	31 65
June,	31 28	19 44	0 57	12 41	27 50
July,	36 11	22 80	0 58	13 89	28 69
August,	39 94	23 95	0 56	16 57	32 22
September,	38 95	22 93	0 55	16 57	33 72
October,	40 12	22 14	0 57	18 55	34 84
Averages,	$36 42	$20 93	$0 61	$16 09	$33 48

4. Cost of Skim-milk at the Selling Price of Three Cents per Quart for Whole Milk.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at ThreeCentsperQuart).	Total Cost of Skim-milk.
1891.								Cents.	
January,	1,413.5	915.0	269.1	1,144.4	3.85	2.49	$35 23	0.63	$7 18
February,	1,643.8	934.0	274.7	1,369.1	3.80	2.16	35 49	1.01	13 82
March,	1,700.2	1,048.0	308.2	1,392.0	4.05	2.50	42 44	0.62	8 57
April,	1,468.1	958.0	281.8	1,186.3	3.90	2.54	37 36	0.56	6 68
May,	1,889.7	1,134.0	333.2	1,556.5	3.60	2.16	40 82	1.02	15 87
June,	1,841.3	1,045.0	307.4	1,533.9	3.10	1.76	32 40	1.49	22 84
July,	1,791.2	1,008.0	296.5	1,494.7	3.20	1.80	32 26	1.44	21 48
August,	1,924.0	1,036.0	304.7	1,619.3	3.50	1.88	36 26	1.33	21 46
September,	1,826.9	1,046.0	307.8	1,519.1	4.00	2.29	41 84	0.85	12 97
October,	1,659.9	963.0	283.2	1,376.7	4.10	2.38	39 48	0.75	10 32
November,	1,424.0	803.0	236.2	1,187.8	4.00	2.24	32 12	0.90	10 60
December,	1,344.0	790.0	232.4	1,111.6	4.00	2.36	31 60	0.79	8 72
Averages,	1,660.4	973.3	286.3	1,374.3	3.76	2.21	$36 44	0.95	$13 37
1892.									
January,	1,460.3	845.0	248.5	1,211.8	4.10	2.38	$34 64	0.75	$9 16
February,	1,612.4	950.0	279.4	1,333.0	4.10	2.42	38 95	0.71	9 42
March,	1,818.0	1,155.0	340.0	1,478.0	3.90	2.45	45 04	0.65	9 50
April,	1,704.4	989.0	290.9	1,413.5	3.70	2.14	36 59	1.03	14 54
May,	1,806.7	1,021.0	300.0	1,506.7	3.10	1.73	31 65	1.50	22 55
June,	1,818.5	873.0	256.8	1,561.7	3.15	1.51	27 50	1.73	27 05
July,	1,602.8	883.0	260.0	1,342.8	3.25	1.78	28 69	1.44	19 40
August,	1,765.8	848.0	249.4	1,516.4	3.80	1.80	32 22	1.36	20 76
September,	1,581.4	843.0	248.0	1,333.4	4.00	2.12	33 72	1.03	13 71
October,	1,614.7	871.0	256.2	1,358.5	4.00	2.16	34 84	1.00	13 61
Averages,	1,678.5	927.8	272.9	1,405.6	3.71	2.04	$34 38	1.12	$15 97

5. Fertilizing Constituents of Cream.

[Average analysis.]

	Per Cent.
Moisture at 100° C.,	75.22
Nitrogen (15 cents per pound),	0.54
Potassium oxide (4½ cents per pound),	0.123
Phosphoric acid (5½ cents per pound),	0.168

6. Conclusions.

1. The nutritive ratio of the feed varied in 1891 from 1 : 4.17 to 1 : 6.74, with an average of 1 : 5.28; in 1892, from 1 : 3.70 to 1 : 5.70, with an average of 1 : 4.60.

2. The percentage of fat in the milk varied in 1891 from 4.15 to 5.21, with an average of 4.70; in 1892, from 3.50 to 4.55, with an average of 4.42.

3. The percentage of total solids varied in 1891 from 13.41 to 14.99, with an average of 14.24; in 1892, from 12.30 to 13.75, with an average of 13.44.

4. The relation of fat to solids not fat in 1891 was 1 : 2.02, while in 1892 it was 1 : 2.04, proving that the lesser yield of fat in 1892 was not due to the influence of the food but rather to the general inferior character of the cows kept.

5. The total cost of feed for one quart of cream amounted in 1891 to 13.93 cents, and in 1892 to 13.35 cents.

6. The net cost of feed for one quart of cream amounted in 1891 to 7.37 cents, and in 1892 to 5.90 cents.

7. The value received for one space of cream varied in 1891 from 3.1 to 4.1 cents, with an average of 3.75 cents; in 1892, from 3.1 to 4.1 cents, with an average of 3.69 cents; which amounted per quart (average) in 1891 to 12.73 cents, and in 1892 to 12.27 cents.

8. The number of quarts of milk required to produce one space of cream in 1891 was 1.73, and in 1892 1.82; or 5.88 quarts of whole milk to produce one quart of cream in 1891, and 6.18 quarts of whole milk to produce one quart of cream in 1892.

9. The net cost of feed per quart of cream averaged in 1891 7.37 cents, and in 1892 5.90 cents. Received per quart of cream in 1891 12.73 cents, and in 1892 12.27 cents, thereby securing a profit of 5.36 cents per quart in 1891, and 6.37 cents in 1892.

For further details concerning results in preceding years, see eighth annual report, pages 54 to 65, and ninth annual report, pages 76 to 82.

Our average statements for the current year apply in each case to only ten months, due to the fact that the financial settlement is made with our local creamery two months after the cream is furnished.

7. *Analyses of Cream.*

Date of Sampling.	Analysis of Cream.			Average Daily Fodder Rations.
	Solids.	Fat.	Solids not Fat.	
1892.				
Jan. 5, .	28.37	20.29	7.08	3 pounds wheat bran, 3 pounds maize feed, 3 pounds cotton-seed meal, 12.06 pounds dent corn stover.
Jan. 12, .	25.13	16.29	8.84	
Jan. 19, .	24.93	12.95	7.98	3 pounds wheat bran, 3 pounds maize feed, 3 pounds cotton-seed meal, 5 pounds hay, 32 pounds dent corn ensilage.
Jan. 26, .	25.89	15.94	9.95	
Feb. 2, .	27.29	19.21	8.08	
Feb. 16, .	25.62	17.21	8.41	
Feb. 23, .	24.01	15.71	8.30	
March 1, .	26.06	17.26	8.80	3 pounds wheat bran, 3 pounds maize feed, 3 pounds cotton-seed meal, 5 pounds hay, 41.39 pounds sweet corn ensilage.
March 8, .	27.92	20.04	7.88	
March 22, .	25.19	16.13	9.06	
April 19, .	25.18	17.15	8.03	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 5 pounds rowen, 15 pounds sugar beets.
May 3, .	26.20	19.01	7.19	
June 7, .	25.61	18.80	6.81	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 5 pounds rowen, 16.22 pounds green rye.
July 19, .	23.40	16.24	7.16	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 5 pounds rowen, 37.71 pounds vetch and oats.
Aug. 16, .	23.76	17.91	5.85	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 5 pounds rowen, 60.8 pounds green fodder.
Aug. 23, .	21.35	14.06	7.29	
Aug. 30, .	23.30	16.75	6.55	
Sept. 6, .	22.90	15.88	8.02	
Oct. 18, .	25.63	16.00	9.63	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 15 pounds hay.
Dec. 3, .	25.28	16.90	8.38	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 15 pounds hay, 15 pounds sugar beets.
Dec. 23, .	25.55	17.00	8.55	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 15.96 pounds corn stover.

8. Average Milk Analyses for Previous Years.

Year.	Number of Cows.	Total Solids.	Fat.	Solids not Fat.	Relation of Fat to Solids not Fat.
1884, ...	4	13.01	3.71	9.30	1:2.51
1885, ...	2	13.33	4.02	9.31	1:2.33
1886, ...	2	12.91	3.97	8.94	1:2.25
1887, ...	8	12.73	3.83	8.90	1:2.32
1888, ...	6	13.27	3.68	9.59	1:2.61
1889, ...	10	13.91	4.31	9.60	1:2.23
1890, ...	7	14.01	4.64	9.37	1:2.02
1891, ...	14	14.24	4.70	9.31	1:2.02
1892, ...	10	13.42	4.42	9.00	1:2.04

The methods for butter and milk analyses can be found in the ninth annual report, pages 84 to 86.

4. Analyses of Milk of Different Breeds of Cows by Babcock Mode (made by an Assistant of the Station at the Request of the Owner of the Cows at their Farms). 1892.

Guernsey.

Number.	Age (Years).	Last Calf dropped.	Pounds of Milk given.			Per Cent. of Butter Fat in Milk.		Pounds of Butter Fat in Day's Milk.	Previous Records.	Daily Ration for Week preceding Test.	Date of Testing (1892).
			P.M.	A.M.	Total.	P.M.	A.M.				
1	7	Aug. 25, 1891,	8.50	7.00	15.50	4.7	5.4	0.78	None kept,	Good pasturage, with 2 quarts of meal, 1 quart of oats, and 4 quarts of bran in addition.	June 13, P.M.; 14, A.M.
2	8	March 23, 1891,	6.00	6.00	12.00	4.0	4.5	0.51	" "		" "
3	9	Sept. 23, 1891,	11.50	8.50	20.00	5.6	5.2	1.09	" "		" "
4	6	Aug. 22, 1891,	4.75	4.00	8.75	6.2	7.1	0.59	" "		" "
5	7	March 21, 1890,	10.25	7.75	18.00	5.6	5.4	0.99	" "		" "
6	7	May 25, 1891,	8.50	6.50	15.00	5.2	5.7	0.81	" "		" "
7	5	May 14, 1892,	14.00	14.50	28.50	4.6	4.9	1.35	" "		" "
8	6	Sept. – 1891,*	5.50	3.75	9.25	6.8	7.0	0.64	" "		" "
9	7	Feb. 21, 1892,	12.50	9.50	22.00	4.4	5.3	1.05	" "		" "
10	9	June 21, 1891,	10.00	8.50	18.50	5.0	5.6	0.98	" "		" "
11	6	May 16, 1890,	8.25	6.00	14.25	5.7	5.4	0.79	" "		" "
12	6	Nov. – 1890,*	7.50	7.00	14.50	6.6	6.9	0.98	" "		" "
13	6	July 25, 1891,	6.50	5.50	12.00	7.0	6.4	0.81	" "		" "
14	6	Aug. 20, 1891,	10.25	8.00	18.25	5.3	6.0	1.02	" "		" "
15	3	Oct. 29, 1891,	11.00	8.25	19.25	5.2	6.8	1.13	" "		" "
16	4	May 20, 1892,	15.00	13.00	28.00	3.7	5.3	1.24	" "		" "
17	–	May – 1892,	11.25	–	–	3.9	3.6	–	" "	Good pasturage,	June 9, P.M.; 10, P.M.
18	–	May – 1892,	16.25	–	–	4.2	4.3	–	" "	" "	" "
19	–	Spring, 1891,	4.25	–	–	5.0	6.6	–	" "	" "	" "
20	–	Feb. – 1892,	7.75	–	–	4.8	4.2	–	" "	" "	" "
21	–	April 25, 1892,	14.75	15.00	29.75	5.7	5.0	1.59	" "	" "	June 9, P.M.; 10, A.M.

* Abortion at seven months.

ANALYSES OF MILK, ETC. — *Continued.*

Guernsey.

Number.	Age (Years).	Last Calf dropped.	Pounds of Milk given. P.M.	Pounds of Milk given. A.M.	Pounds of Milk given. Total.	Per Cent. of Butter Fat in Milk. P.M.	Per Cent. of Butter Fat in Milk. A.M.	Pounds of Butter Fat in Day's Milk.	Previous Records.	Previous Records. Pounds.	Daily Ration for Week preceding Test.	Date of Testing (1892).
22	-	Oct. - 1891,	11.25	11.00	22.25	4.7	5.9	1.28	None kept,	.	Good pasturage, with 3 quarts of a mixture of equal parts of oats and shorts and on an average 3 quarts of corn meal (some receiving 2 quarts, others 4).	June 9, P.M.; 10, A.M.
23	-	Feb. - 1892,	8.50	8.50	17.00	5.1	7.0	1.03	" "	.		" "
24	-	June 17, 1891,	4.25	3.50	7.75	9.2	6.2	0.61	" "	.		" "
25	-	Feb. - 1892,	10.75	10.25	21.00	5.5	4.9	1.09	" "	.		" "
26	-	April 21, 1892,	11.25	7.25	18.50	5.2	4.5	0.91	" "	.		" "
27*	-	April 19, 1892,	15.25	15.50	30.75	3.2	4.6	1.21	" "	.		" "
28	-	Nov. - 1891,	11.75	11.50	23.25	4.0	4.5	0.99	" "	.		" "
29	-	Spring, 1891,	6.00	5.50	11.50	3.9	4.6	0.74	" "	.		" "
30	-	April 30, 1892,	12.50	11.50	24.00	4.0	4.7	1.04	" "	.		" "
31	-	Feb. 12, 1892,	15.06	15.13	30.19	4.65	4.8	1.43	Feb. 21 — June 4,	2,706	Good pasturage, with hay night and morning, and 2½ quarts corn meal and 3 quarts of shorts; No. 31 received 3 quarts of corn meal and 4 quarts of shorts.	June 3, P.M.; 4, A.M.
32	-	Dec. 15, 1891,	11.00	10.25	21.25	5.1	6.1	1.20	Dec. 20 — June 4,	3,791		" "
33	-	Jan. 28, 1892,	11.38	10.50	21.88	4.8	5.1	1.08	Feb. 7 — June 4,	2,619		" "
34	-	Nov. 15, 1891,	12.13	10.75	22.88	5.1	5.9	1.25	Dec. 6 — June 4,	3,625		" "
35	-	Nov. 25, 1891,	7.75	7.06	14.81	6.3	6.6	0.95	Dec. 6 — June 4,	2,792		" "
36	-	Dec. 29, 1891,	14.44	12.31	26.75	5.0	4.8	1.31	Jan. 3 — June 4,	4,184		" "
37	2½	Feb. 13, 1892,	11.50	10.50	22.00	4.2	4.0	0.90	Feb 15 — May 31,	2,348.25	Good pasturage, and green rye once a day; the old cows received 4 quarts of corn meal and 4 quarts of shorts; the young cows 2 quarts of corn meal and 4 quarts of shorts.	June 10, P.M.; 11, A.M.
38	9	Feb. 15, 1892,	11.00	11.50	22.50	4.9	5.5	1.17	Feb. 17 — May 31,	2,615.75		" "
39	10	April - 1891,	11.25	11.00	22.25	4.0	4.4	0.93	May - - -	716.50		" "
40	2	Feb. 15, 1892,	8.00	8.00	16.00	4.9	5.1	0.80	Feb. 17 — May 31,	1,647		" "
41	6	Jan. 5, 1892,	11.00	12.00	23.00	4.1	5.2	1.08	Jan. 7 — May 31,	3,561.75		" "
42	2	Feb. 1, 1892,	8.75	8.50	17.25	4.1	4.1	0.71	Mar. 1 — May 31,	1,493		" "
43	9	Jan. 21, 1892,	9.00	9.00	18.00	5.4	4.9	0.93	Jan. 23 — May 31,	2,199	Good pasturage, and green rye once a day; the old cows received 4 quarts of corn meal and 4 quarts of shorts; the young cows 2 quarts of corn meal and 4 quarts of shorts.	" "
44	3	Oct. 2, 1891,	8.25	8.25	16.50	4.1	3.8	0.65	Dec. 1 — May 31,	3,204.25		" "
45	6	Jan. 21, 1892,	13.25	12.00	25.25	3.9	4.2	1.02	Jan. 23 — May 31,	3,667		" "
46	10	Feb. 6, 1892,	9.00	8.75	17.75	4.0	4.9	0.79	Feb. 8 — May 31,	2,418.25		" "
47	3	Dec. 14, 1891,	9.00	8.50	17.50	4.1	4.1	0.72	Dec. 16 — May 31,	3,367.50		" "
48	2½	Dec. 2, 1891,	10.50	10.50	21.00	5.2	4.1	0.98	Dec. 4 — May 31,	3,691.50		" "
49	3	Sept. - 1891,	8.50	8.50	17.00	3.8	3.8	0.65	Dec. 1 — May 31,	2,941.75		" "
50	6	Sept. 29, 1891,	11.25	11.00	22.25	5.0	4.6	1.07	Dec. 1 — May 31,	4,008.75		" "
51	6	Nov. 16, 1891,	15.50	16.50	32.00	4.0	4.2	1.31	Dec. 1 — May 31,	5,554.75		" "
52	2	Feb. - 1892,	6.75	7.00	13.75	4.0	5.4	0.65	Mar. 1 — May 31,	1,347		" "
53	3	Aug. 30, 1892,	10.00	10.00	20.00	4.2	3.9	0.82	Dec. 1 — May 31,	3,348.50		" "

54	13	Jan.	4, 1892,	13.75	10.00	23.75	5.2	6.4	1.36	None kept,	Good pasturage,	June 29, A.M. and P.M.
55	12	Jan.	17, 1892,	7.75	6.25	14.00	3.6	4.0	0.53	" "	" "	" "
56	9	May	8, 1892,	15.00	9.00	24.00	4.0	4.85	1.04	" "	" "	" "
57	9	May	27, 1892,	18.50	16.00	34.50	4.6	5.15	1.68	" "	" "	" "
58	5	April	6, 1891,	9.00	7.00	16.00	4.45	4.3	0.70	" "	" "	" "
59	4	Feb.	13, 1891,	7.25	7.00	14.25	5.1	6.4	0.81	" "	" "	" "
60	4	June	5, 1891,	9.00	7.25	16.25	5.0	5.5	0.85	" "	" "	" "
61	4	April	2, 1891,	8.50	8.00	16.50	4.5	5.2	0.80	" "	" "	" "
62	3	June	18, 1892,	13.00	11.00	24.00	4.8	6.2	1.31	" "	" "	" "
63	5	March	3, 1891,	4.50	4.75	9.25	4.9	4.8	0.45	" "	Good pasturage, and No. 70 received 2 quarts of corn meal and 2 quarts of wheat bran in addition.	June 15, P.M.; 16, A.M.
64	5	Feb.	25, 1892,	9.50	8.75	18.25	3.9	4.4	0.76	" "		" "
65	4	April	10, 1892,	9.88	7.62	17.50	4.2	4.0	0.72	" "		" "
66	3	April	– 1891,	6.50	5.00	11.50	4.4	4.2	0.50	" "		" "
67	18	June	10, 1891,	6.00	5.00	11.00	3.8	4.4	0.45	" "		" "
68*	5	April	10, 1892,	6.88	7.00	13.88	3.5	2.8	0.44	" "		" "
69	3	May	1, 1892,	9.25	7.25	16.50	4.8	4.7	0.68	" "		" "
70	6	May	9, 1892,	16.50	12.75	29.25	4.0	3.1	1.06	" "		" "
71	3	July	16, 1892,	10.00	12.00	22.00	3.75	3.50	0.80	" "	Pasturage, with about 20 pounds of green corn fodder and 4 quarts of a mixture consisting of 3 weight parts of corn meal and 2 weight parts of wheat bran in addition.	July 29, P.M.; 30, A.M.
72	3	Sept.	12, 1891,	6.00	7.00	13.00	5.00	5.00	0.65	" "		" "
73	3	Oct.	– 1891,	3.50	3.00	6.50	5.10	5.30	0.34	" "		" "
74	4	July	– 1891,	8.00	7.00	15.00	5.75	5.00	0.81	" "		" "
75	3	Dec.	21, 1891,	7.00	7.00	14.00	4.80	5.00	0.68	" "		" "
76	4	July	5, 1892,†	7.00	8.25	15.25	5.10	4.80	0.75	" "		" "
77	3	Jan.	16, 1892,	8.00	8.00	16.00	4.50	4.40	0.71	" "		" "
78	4½	Oct.	11, 1891,	6.00	6.50	12.50	4.40	3.85	0.51	" "		" "
79	10	March	21, 1892,	12.00	10.00	22.00	4.30	4.20	0.93	" "		" "
80	7	Feb.	8, 1892,	12.25	11.00	23.25	4.60	3.60	0.96	" "		" "
81	4	July	24, 1892,	12.00	10.50	22.50	2.90	3.60	0.72	" "		" "
82	5½	Dec.	10, 1891,	8.00	7.00	15.00	4.80	3.40	0.62	" "		" "
83	6	Oct.	10, 1891,	4.00	4.00	8.00	4.90	4.65	0.38	" "		" "
										Pounds.		
84	3	June	28, 1892,	10.50	10.75	21.25	5.30	5.80	1.18	June 28 — Aug. 1, 409.25	Pasturage, with 6 pounds of a mixture consisting of equal weight parts of corn meal, wheat bran, new-process linseed meal and cotton-seed meal; No. 18 received 12 pounds of the grain mixture.	July 15, P.M.; 16, A.M.
85	3½	Aug.	18, 1891,	10.50	9.50	20.00	5.30	5.20	1.05	Aug. 18, '91 — Aug. 1, 6,438.50		" "
86	5½	July	6, 1892,	12.75	14.00	26.75	5.00	4.95	1.33	July 6 — Aug. 1, 215		" "
87	4	March	26, 1891,	6.00	7.00	13.00	4.60	6.20	0.71	Mar. 26, '91 — Aug. 1, 7,150		" "
88	6	May	18, 1892,	18.94‡	17.50	36.44	3.90	3.50	1.35	May 18 — Aug. 1, 2,704		July 16, A.M. and P.M.
89	6	May	9, 1892,	9.14	7.52	16.66	4.80	4.60	0.78	– – –	– – –	– –
90	5	March	3, 1891,	2.15	2.15	4.30	7.10	6.80	0.30	– – –	– – –	– –
91	5	Feb.	25, 1892,	3.22	2.69	5.91	5.20	5.20	0.31	– – –	– – –	– –
92	4	April	10, 1892,	8.06	4.84	12.90	6.30	5.70	0.78	– – –	– – –	– –
93	3	May	1, 1892,	4.84	4.30	9.14	4.80	5.20	0.46	– – –	– – –	– –
94	3	April	– 1891,	2.69	2.15	4.84	5.50	6.20	0.28	– – –	– – –	– –

* In heat at time of test. † Carried calf only seven months. ‡ Milked three times a day. This is the sum of the noon and evening milking (8.50 and 13.00 pounds); tested at noon.

ANALYSES OF MILK, ETC. — *Continued.*

Holstein.

Number.	Age (Years).	Last Calf dropped.	Pounds of Milk given.			Per Cent. of Butter Fat in Milk.		Pounds of Butter Fat in Day's Milk.	Previous Records (Milk).	Daily Ration for Week preceding Test.	Date of Testing (1892).
			P.M.	A.M.	Total.	P.M.	A.M.		Pounds.		
1	2½	April 28, 1892,	10.00	10.13	20.13	3.80	3.50	0.73	April 28 — Aug. 1, 1,977	Pasturage, with 6 pounds of a mixture consisting of equal weight parts of corn meal, wheat bran, new-process linseed meal and cotton-seed meal.	July 15, P.M.; 16, A.M.
2	3	Jan. 13, 1892,	9.12	8.88	18.00	2.90	2.50	0.49	Jan. 13 — Aug. 1, 4,849		" "
3	3	Jan. 10, 1892,	9.00	8.88	17.88	3.20	1.80	0.45	Jan. 10 — Aug. 1, 4,520		" "
4	3	Nov. 28, 1891,	8.00	8.88	16.88	3.15	2.80	0.50	Nov. 28, '91 — Aug. 1, 4,442		" "
5	6	Feb. 20, 1892,	16.25	16.38	32.63	4.40	3.50	1.29	Feb. 20 — Aug. 1, 7,274		" "
6	5	Dec. 20, 1891,	14.62	15.38	30.00	2.60	4.40	1.06	Dec. 20, '91 — Aug. 1, 8,123		" "
7	5	Jan. 6, 1892,	19.37	19.38	38.75	2.50	2.10	0.89	Jan. 6 — Aug. 1, 9,177		" "
8	2	April 27, 1892,	10.75	11.25	22.00	3.00	1.80	0.53	April 27 — Aug. 1, 1,819		" "
9	3	June 27, 1891,	6.00	6.63	12.63	3.10	2.80	0.37	June 27, '91 — Aug. 1, 7,379		" "
10	3	June 14, 1891,	7.12	7.38	14.50	3.40	4.00	0.54	June 14, '91 — Aug. 1, 7,394		" "
11	3	Feb. 10, 1892,	9.87	10.13	19.00	2.80	1.85	0.46	- - -		" "
12	3	June 1, 1892,	18.50	21.00	39.50	2.00	2.40	0.87	Feb. 10 — Aug. 1, 1,928		" "
13	3	July 2, 1892,	-	18.75	-	-	3.00	-	July 2 — Aug. 1, 409	Pasturage, with 12 pounds of the above grain mixture.	July 16, A.M. and P.M.
14	7	May 11, 1891,	-	2.00	-	-	2.70	-	May 11, '91 — Aug. 1, 13,688		" "

Analyses of Milk, etc. — *Concluded.*

Holstein.

Number.	Age (Years).	Last Calf dropped.	Pounds of Milk given.				Per Cent. of Butter Fat in Milk.		Pounds of Butter Fat in Day's Milk.	Previous Records (Milk).	Daily Rations for Week preceding Test.	Date of Testing (1892).
			A.M.	M.	P.M.	Total.	A.M.	P.M.		Pounds.		
15	7	April 27, 1892,	23.75	19.44	15.31	58.50	1.80	3.60	1.68	April 27 — Aug. 1, 4,697	Pasturage, with 12 pounds of a mixture consisting of equal weight parts of corn meal, wheat bran, new-process linseed meal and cotton-seed meal.	July 16, A.M. and P.M.
16	7	June 25, 1892,	19.56	14.94	15.06	49.56	2.00	3.60	1.46	June 25 — Aug. 1, 1,495		" "
17	5	April 13, 1892,	19.25	15.12	16.63	51.00	2.00	3.40	1.46	April 13 — Aug. 1, 5,805		" "
18	7	June 19, 1892,	24.00	16.00	20.00	60.00	2.20	3.90	1.93	June 19 — Aug. 1, 2,235		" "
19	6½	June 1, 1892,	25.00	16.00	23.00	64.00	3.80	2.10	1.77	June 1 — Aug. 1, 3,075		" "
20	9	April 27, 1892,	18.00	12.75	14.50	45.25	2.70	3.40	1.41	April 27 — Aug. 1, 4,082		" "
21	4	June 1, 1892,	18.12	14.69	14.44	47.25	3.00	4.10	1.74	June 1 — Aug. 1, 976		" "

5. Discussion on Fodder Articles and Fodder Supplies.

[Home-raised Fodder Articles. — Commercial Feed Stuffs. — 1892.]

The fodder articles used in the preparation and compounding of the daily diet of all kinds and conditions of farm live stock are, as a rule, obtained from two distinctly different sources. They are either raised upon the farm and are used usually without any material change in composition, or they are bought in the general market, and are in that case usually the by-products or waste materials of various other branches of industry, as oil works, flour mills, starch works, glucose factories, breweries, etc.

The home-raised fodder crops furnish in the majority of cases the coarse fodder constituent of the daily diet, while the waste or by-products of other industries furnish the fine or grain feed portion of the daily fodder rations. A rational and economical system of stock feeding has assigned to each of these two groups of feed stuffs its proper position in the daily diet of all kinds of farm live stock, with special reference to their general character, adaptation and composition, as well as to good economy and particular efficiency.

A liberal and economical supply of *both classes* of *fodder articles* is to-day recognized as an indispensable requirement of an economical system of stock feeding. To meet our present market condition of the products of the dairy and of the meat supply with any reasonable prospect of a satisfactory compensation for capital invested and labor spent, calls, if possible, for cheaper and more efficient fodder rations than in the majority of instances are in current use.

The importance of a serious and careful consideration of the present condition of our fodder supplies, from both above-stated sources, forces itself from day to day more, not only upon the attention of every farmer, but of all parties interested in the support of our animal industry.

The controlling influence of the temporary local market cost of some of our most prominent current fodder articles on the cost of the production of milk and meat, has been for years pointed out in our bulletins and annual reports, in con-

nection with a description of numerous feeding experiments with milch cows, growing steers, lambs and pigs. An examination of our previous statements concerning the influence of the particular kind of feed stuffs used in the composition of the daily fodder rations on the *market cost*, as well as on the *net cost*, of the feed consumed in the operation, cannot fail to show some striking instances, proving in a marked degree the previously pointed-out circumstance.

As the fodder for our farm live stock comes from two different sources, of equal importance as far as variety, economy and efficiency are concerned, it seems but proper to consider our chances for the improvement of our fodder supply under two separate headings, namely: —

1. Home-raised fodder articles.
2. Commercial feed stuffs.

1. *Home-raised Fodder Articles.*

On various previous occasions, and in particular in Bulletin No. 36, an attempt was made to show that an increase in the production of cultivated annual fodder crops, aside from Indian corn or maize, will tend to increase in an economical way the general productiveness of our farm lands in case of a mixed system of farm industry. The introduction of a greater variety of reputed fodder crops, in particular of the clover family (*Leguminosæ*), it was stated, would prove with us, as it had proved elsewhere, an efficient means to increase not only in an economical way the general productiveness of our farm lands, but tend to *cheapen the cost of feed* for all kinds of farm live stock. A short abstract from the above-stated bulletin may suffice on this occasion to show the standpoint assumed in the matter: —

A careful inquiry into the history of agriculture has shown that the original productiveness of farm lands in all civilized countries, even in the most favored localities, has suffered in the course of time a gradual decline. This general decline in the fertility of the soil under cultivation has been ascribed, with much propriety in the majority of instances, mainly to two causes, namely: —

A gradual but serious reduction in the area occupied *by forage crops*, natural *pastures* and *meadows;* and a marked decline in the

annual yield of fodder upon large tracts of lands but ill suited for a permanent cultivation of grasses, — the main reliance of fodder production at the time.

A serious falling off in the annual yield of pastures and meadows was followed usually by a gradual reduction in farm live stock, which in turn caused a falling off in the principal home resource of manurial matter.

This chapter in the history of farm management has repeated itself in most countries. The unsatisfactory results of that system of farming finds still an abundant illustration in the present exhausted condition of a comparatively large area of farm lands in New England.

Careful investigations carried on during the past fifty years for the particular benefit of agriculture have not only been instrumental in recognizing and pointing out the principal causes of an almost universal periodical decline of the original fertility of farm lands, but have also materially assisted by field experiments and otherwise in introducing efficient remedies to arrest the noted decline in the annual yield of our most prominent farm crops.

As a scanty supply of manurial matter, due to a serious falling off of one of the principal fodder crops, grasses, was found to be one of the chief causes of less remunerative crops, and thus indirectly has proved to be the main cause of an increase in the cost of the products of the animal industry of the farm, milk and meat, it is but natural that the remedies devised should include, as one of the foremost recommendations, *a more liberal production of nutritious fodder crops.*

The soundness of this advice is to-day fully demonstrated in the most successful agricultural regions of the world. An intensive system of cultivation has replaced in those localities the extensive one of preceding periods; although the area under cultivation for the production of general farm crops has been reduced, the total value of the products of the farm has increased materially in consequence of a more liberal cultivation of reputed fodder crops. The change has been gradual and the results are highly satisfactory.

Viewing *our own present condition*, we notice that well-paying grass land, good natural meadows and rich and extensive pastures are rather an exception than the rule. The benefits derived from indifferently yielding natural pastures are often more apparent than real; the low cost of the production of the fodder is frequently in a large degree set off by a mere chance distribution of the manure produced.

A continued cultivation of but few crops upon the same land, without a liberal, rational system of manuring, has caused in many

instances a one-sided exhaustion of the land under cultivation. This circumstance has frequently been brought about in a marked degree by a close rotation of mixed grasses (meadow growth) and of our next main reliance for fodder, the corn (maize). Both crops require potash and phosphoric acid in similar proportion (4 potassium oxide to 1 phosphoric acid), and both require an exceptional amount of the former.

There is good reason to assume that the low state of productiveness of many of our farms, so often complained of, is largely due to the fact that crops have been raised in succession for years, which, like those mentioned, have consumed one or the other essential article of plant food in an exceptionally large proportion, and thereby have gradually unfitted the soil for their remunerative reproduction, while a liberal supply of other equally important articles of plant food is left inactive behind.

As the amount of *available plant food* contained in the soil represents largely the working capital of the farmer, it cannot be otherwise but that the practice of allowing a part of it to lie idle must reduce the interest on the investment.

Personal local observation upon the lands assigned for the use of the station has furnished abundant illustration of the above-described condition of farm lands. In one instance it was noticed that a piece of old, worn-out grass land, after being turned under and properly prepared, as far as the mechanical condition of the soil was concerned, produced, *without any previous application of manure*, an exceptionally large crop of horse beans and lupine, — two reputed fodder crops.

A similar observation was made during the past season, when lands which for years had been used for the production of English hay and corn were used for the cultivation of Southern cow-pea, serradella and a mixed crop of oats and vetch, to serve as green fodder for milch cows. The field engaged for the production of these crops was not manured, because it was to be prepared for a special field experiment during the following season. An area of this land which, under favorable circumstances, would not produce more than six tons of green grass at the time of blooming, yielded nine to ten tons of green vetch and oats, ten tons of green Southern cow-pea, and from twelve to thirteen tons of green serradella.

The exceptional exhaustion of our lands in potash has also been shown abundantly by detailed description of experiments with fodder corn in previous annual reports.

Our local results during past years tend to confirm the opinion held by successful agriculturists that dry grass lands which are in an exceptional degree inclined to a spontaneous overgrowing by

an inferior class of fodder plants and weeds, if at all fit for a more thorough system of cultivation, ought to be turned by the plough and subsequently planted with *some hoed crop*, to kill off the foul growth and to improve the physical and chemical condition of the soil. *Such lands prove in many instances ultimately a far better investment when used for the raising of other fodder crops than grasses.*

The less the variety of crops raised in succession upon the same lands, the more one-sided is usually the exhaustion of the soil, and the sooner, as a rule, will be noticed a decrease in their annual yield. The introduction of a greater variety of fodder plants enables us to meet better the differences in local conditions of climate and of soil, as well as the special wants of different branches of farm industry. In choosing plants for that purpose, it seems advisable to select crops which would advantageously supplement our leading fodder crop (aside from the products of pastures and meadows), the fodder corn and corn stover.

Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, serradella, peas, beans, lupines, etc., is in a particular degree well qualified for that purpose. They deserve also a decided recommendation in the interest of a wider range for the introduction of economical systems of rotation of crops, under various conditions of soil and different requirements of markets. Most of these fodder plants have an extensive root system, and for this reason largely draw their plant food from the lower portion of the soil. The amount of stubble and roots they leave behind after the crop has been harvested is exceptionally large, and decidedly improves both the physical and chemical condition of the soil. The lands are subsequently better fitted for the production of shallow growing crops, as grains, etc. Large productions of fodder crops assist in the economical raising of general farm crops; although the area devoted to cultivation is reduced, the total yield of the land is usually more satisfactory.

Believing in the soundness of the above-stated views, it has been for years a special task of our work at the station to investigate upon our farm lands the comparative merits, if any, of a variety of fodder plants new to our locality and of a fair reputation elsewhere, as may have been noticed in our annual report. From among those fodder plants which showed a fair degree of adaptation to our soil and climate we have selected for several years past a few for cultivation on a large scale, to increase our fodder supply during the summer and winter season, either as green fodder or in the form of ensilage and hay.

The new crops thus far selected for that purpose are all annual leguminous plants (clover family), as summer vetch, Scotch tares, soja bean, serradella, horse bean and Southern cow-pea. These crops can claim a higher nutritive value than the grasses, and they yield in the majority of cases a larger return per acre. They are readily and with advantage introduced into most local systems of rotation, they tend to increase materially the nitrogen resource of the soil they are raised on in an economical way, besides improving the physical and chemical conditions of the soil in various directions.

One of the principal aims in the cultivation of fodder crops of every description ought to be an increase of their nitrogen containing organic constituents as far as practicable. This result is of special interest in the dairy industry, for milch cows, among full-grown animals, require an exceptionally nutritious diet to do their best.

No class of farm crops shows in a more marked degree the influence of a liberal use of manure. Both the quantity and quality of these crops are materially improved when raised upon lands in a fair state of fertility. Exhausted lands produce invariably an inferior quality of fodder crops of its kind, as far as the amount of their nitrogen-containing organic constituents is concerned. *A liberal production of nutritious annual fodder crops of the right kind improves our chances of supporting more farm live stock, tends to increase our supply of home-made manure, and ultimately becomes the chief reliance of a remunerative mixed farm industry.*

Our trials on a small scale with new fodder crops during the past year include the following: —

Summer vetch,
Soja bean,
Bokhara clover,
Sanfoin,
Horse bean,
Cow-pea,
Yellow trefoil,
Serradella,
Prickly comfrey,
Flat-pea or *Lathyris sylvestris*,
Kidney vetch,
Blue lupine,
Yellow lupine,
White lupine,
Silver-hull buckwheat,
Japanese buckwheat,
Common buckwheat,
Summer rape,
Winter rape,
Artichoke (Jerusalem),
Sugar beet.

Several of the above-enumerated more or less reputed fodder plants have been for some years past successfully cultivated upon the fields of the station, as may have been noticed from previous communications. Some of them have been raised again during the past season on a becoming scale to increase our fodder supply for milch cows, etc., as green fodder during summer and autumn and as ensilage during winter and spring. A summary of our results may be noticed in the following tabular statement. The estimate in regard to meadow growth is based on the results obtained by us on exceptionally good grass land (two tons of first cut and one ton of second cut hay). The annual average yield of meadows for the entire State does not much exceed one ton of hay.

CROP.	Yield per Acre (Tons).	Dry Matter (Per Cent.).	Dry Matter per Acre (Pounds).	Nitrogen in Dry Matter (Per Cent.).	Nitrogen per Acre (Pounds).
Fodder corn (kernels glazing),	18	31.47	11,329	1.02	116
Serradella,	12	17.97	4,313	2.42	104
Vetch and oats,	8.05	17.98	2,894	2.68	78
Soja bean,	11.1	26.80	5,949	1.19	71
Hay,	2	87.72	3,509	1.64	58
Rye,	7	37.89	4,406	0.85	37
Peas and oats,	5	13.68	1,368	2.63	36
Rowen,	1	89.79	1,795	2.00	36
Hungarian (second crop after rye),	2.5	25.69	1,285	1.50	18

Rye, vetch and oats, peas and oats, part of soja bean, of corn and of serradella have been fed as green fodder or as hay, and the remainder of green corn and soja bean, serradella and Hungarian, is on hand in silos as mixed ensilage for winter use.

2. *Commercial Feed Stuffs.*

The name commercial feed stuff or concentrated commercial feed stuffs is usually applied to a class of substances offered for sale in our markets which, in the majority of cases, are the waste or by-products of other branches of industry. Some of these articles, as brans, middlings and oil cakes have been for years quite generally used in the daily diet of all kinds of farm live stock; others, as the gluten meal,

gluten feed, corn germ meal, dried brewers' grain, malt sprouts, etc., are but recently more generally offered for a similar purpose.

Their importance as an additional valuable fodder supply for the support of every branch of animal industry on the farm and elsewhere has become from year to year more conspicuous, on account of a marked increase of the supply of well-known articles, as well as of the introduction of many new kinds. Their consumption is apparently daily increasing, and seems to keep step with the supply.

The special value claimed for commercial feed stuffs as an important source of fodder supply rests in the main on their fitness to supplement advantageously our coarse home-raised fodder crop in the interest of a higher feeding effect and of a better economy. A frequently good mechanical condition, as well as an exceptionally valuable chemical composition, adapt many of them in a high degree for that purpose.

As no single farm crop or any part of them has been found to supply economically and efficiently to any considerable extent the particular wants of food of our various kinds of farm live stock to secure the best possible results, it becomes a matter of first importance from a mere financial stand-point to know how to supplement our current farm crops to meet the wants of each kind of animals under various circumstances in a desirable degree To secure the highest feeding effect of each fodder article raised upon the farm is most desirable in the interest of good economy.

Practical experience in the dairy has thus far abundantly shown that the efficiency of a daily diet does not so much depend on the mere use of more or less of one or the other reputed fodder article as on the presence of suitable fodder articles which contain the *three essential groups of food constituents*, i. e., *organic nitrogenous*, *non-nitrogenous and mineral constituents of plants*, in a desirable form, and in such relative proportions and quantities as have been recognized to be necessary to meet efficiently the food supply of the dairy cow. Similar relations are known to exist in regard to the diet best adapted in case of all kinds of animals. *An economical system of stock feeding has to select among the suitable fodder articles those which furnish the required quality and proportion of the three recognized*

essential food constituents in a digestible form, at the lowest cost.

Actual observations in stock feeding fully confirm the correctness of the above statement, that a judicious selection from among the current commercial feed stuffs, for the purpose of serving in connection with one or more of our home-raised fodder plants as a fodder ingredient of the daily diet, does, as a rule, tend not only to improve their food value, but also lowers in the majority of cases the net cost of the feed consumed. For more details regarding the determination of the intrinsic value of fodder rations I have to refer on the present occasion, for obvious reasons, to preceding annual reports.

The majority of commercial feed stuffs occupy in a rational system of stock feeding a similar position to our home-raised fodder crops, as is commonly conceded to the commercial fertilizer, with reference to the barn-yard manure for the production of farm crops; they serve for the preparation of a complete diet under different conditions and for different purposes. The individual merits of each of them become in the same degree better appreciated, as the principles which govern animal nutrition are *more generally* understood, and *find a due recognition* in our modes of compounding the daily diet for different kinds as well as for different conditions of the same kind of animals. *They are as a class to-day considered indispensable for a remunerative management of every branch of animal industry on the farm and elsewhere.*

Many of the commercial feed stuffs contain, aside from a liberal amount of phosphoric acid and potash, an exceptionally large percentage of nitrogen. This circumstance gives them a special claim, independent of their respective food value for animals. A liberal addition of these feed stuffs to the daily diet of any kind of animal imparts to the manurial refuse resulting from their use a corresponding higher commercial and agricultural value as a valuable source of plant food. A judicious and liberal introduction of a quite numerous class of commercial feed stuffs into the daily fodder supply of the animals kept on the farm is for this reason *deservedly* recommended as a safe and economical

way to increase the home production of plant food in the interest of an increase in the fertility of the farm lands.

As the financial success of a mixed system of farming in particular depends to a considerable degree on the character, the amount and the cost of production of the manurial refuse secured in connection with the special farm industry carried on at the time, it seems to need no further argument to prove that the relation which exists between the temporary *market cost* of the particular feed stuff under consideration and the *market value* of the manurial elements which it contains deserves a serious consideration when devising an efficient and at the same time an economical diet.

The character and commercial value of the manurial refuse obtainable from any kind of feed stuff, under otherwise corresponding conditions, stands in a direct relation to more or less of the different essential fertilizing constituents — phosphoric acid, potash, and in particular nitrogen — it contains. The commercial value of these three important articles of plant food found frequently in prominent commercial feed stuffs equals in many instances more than one-half of the market cost of the particular fodder ingredient in question.

The subsequent tabular statement may serve as an illustration of these relations between market cost and fertilizing value of some current reputed fodder articles: —

NAME OF FEED STUFF.	Market Cost (per Ton)	Manurial Value (per Ton).
Corn meal,	$24 00	$7 31
Gluten meal (Chicago),	28 00	14 72
Chicago maize feed,	25 00	13 25
Buffalo gluten feed,	23 00	12 57
Cotton-seed meal,	28 00	23 52
Linseed meal (old process),	26 00	19 22
Linseed meal (new process),	27 00	20 37
Wheat middlings,	17 00	9 50
Wheat bran,	17 00	13 23
Dried brewers' grain,	23 00	9 96
English hay (first cut of meadows),	15 00	5 92
Rowen (second cut of meadows),	15 00	7 00
Corn fodder,	7 00	4 55
Corn stover,	5 00	3 75
Corn ensilage,	2 50	1 53
Sugar beets,	5 00	1 21
Mangold roots,	4 00	1 01

The above-stated market cost is subject to periodical changes, and the commercial value of their fertilizing constituents varies more or less with the quality of each kind. This feature does not affect materially the force of the point made.

A due appreciation of the previously pointed out favorable features regarding the peculiar character of a numerous class of commercial feed stuffs has caused a steady increase in their consumption on the farm and elsewhere. *The money invested by farmers for securing commercial feed stuffs as an additional food supply for home consumption exceeds to-day many times the amount spent for commercial fertilizers.*

As no single commercial feed stuff can be expected to meet our present demand for these articles, nor can claim to be the most economical one under varying market conditions, and with due appreciation of the varying character of our home-raised fodder supply, it is but proper that every new addition in suitable kinds should receive a deserved attention, and subsequently an actual trial to ascertain its individual merits.

A considerable number of these feed stuffs has already been tried at this station during past years, in connection with our feeding experiments with milch cows, growing steers, lambs and pigs, as may have been noticed in our periodical reports; others are at present on trial. The articles used on those occasions were as a rule bought in the general market. A still larger number of different kinds have been analyzed by us at the request of farmers and dealers in feed stuffs; the samples were usually sent on for that purpose. In regard to the former, there can be no reasonable doubt about their identity; as far as the latter are concerned, the responsibility of furnishing fair representative samples rests in some instances with the parties asking for the analyses.

The results of our analyses of commercial feed stuffs are embodied in the subsequent tabular statement. The record of the analyses is here purposely confined to the extremes noticed, as far as the percentage of *fat* and *nitrogen-containing* organic matter or crude protein are concerned, to engage a special attention in that direction: —

NAME OF FEED STUFF.	Analyses.	Dry Matter (Per Cent.).			Dry Matter contains					
					protein (per cent.).			fat (per cent.).		
		Maximum.	Minimum.		Maximum.	Minimum.		Maximum.	Minimum.	
*Corn meal,	29	89.95	82.96	–	15.57	9.73	–	5.08	3.10	–
*Gluten meal (Chicago),	22	93.50	68.32	–	39.28	25.94	–	12.05	3.92	–
*Gluten feed (Buffalo),	3	93.19	91.03	–	31.05	26.16	–	18.46	11.73	–
Dick gluten flour,	1	–	–	92.93	–	–	33.89	–	–	17.11
Corn germ meal,	1	–	–	90.65	–	–	28.26	–	–	11.82
*Maize feed (Chicago),	3	91.40	90.25	–	29.40	21.33	–	7.90	6.15	–
Dick gluten feed,	1	–	–	91.01	–	–	8.51	–	–	2.26
Corn screenings,	1	–	–	88.98	–	–	8.29	–	–	4.48
Starch feed,	1	–	–	42.96	–	–	22.41	–	–	10.17
Coon gluten meal,	1	–	–	92.13	–	–	25.03	–	–	10.48
Corn germ feed,	1	–	–	92.45	–	–	10.81	–	–	12.17
Hominy meal,	4	91.89	88.68	–	11.88	6.77	–	12.22	4.89	–
*Wheat kernels,	1	–	–	89.42	–	–	13.35	–	–	1.79
*Wheat bran,	35	92.58	86.30	–	20.54	15.67	–	6.08	2.80	–
*Wheat middlings,	6	90.65	87.57	–	19.21	15.13	–	6.46	3.19	–
*Rye bran,	2	91.82	86.30	–	18.98	16.52	–	3.03	2.07	–
*Rye middlings,	1	–	–	87.46	–	–	13.15	–	–	5.61
*Ground barley,	4	89.09	82.59	–	14.93	10.42	–	2.38	1.69	–
*Spent brewers' grain,	4	93.02	88.00	–	33.16	16.08	–	6.29	1.95	–
Malt sprouts,	1	–	–	84.63	–	–	27.17	–	–	3.85
Oat feed,	1	–	–	90.66	–	–	14.06	–	–	8.23
Buckwheat middlings,	1	–	–	88.49	–	–	25.49	–	–	7.53
*Cotton-seed meal,	19	94.31	88.81	–	51.79	36.54	–	14.72	9.47	–
Cotton hulls,	2	89.83	88.55	–	5.36	4.99	–	4.27	2.36	–
*Linseed cake (old process),	7	92.52	88.50	–	39.97	30.98	–	9.87	6.24	–
*Linseed cake (new process),	5	94.94	88.17	–	41.02	35.30	–	4.08	2.17	–

Articles marked * have been bought in the market, or were raised on the land of the station, and there can be no reasonable doubt about fair sampling. The remainder were sent on with name recorded above.

A careful examination of the preceding partial analyses of current commercial feed stuffs cannot fail to show *the existence of most serious variation in the amount of the two most costly food constituents, in case of the same kind.* The differences noticed in that direction affect in many instances, in a marked degree, the food value of the particular article as well as its comparative money value. Some of these variations may be due to differences in the processes at the time employed in the parent industry. *The fact that the majority of this class of feed stuffs are waste or by-products of other industries renders them in an exceptional degree liable to changes in composition. This feature in their production deserves a most careful consideration, from a financial point of view, on the part of the buyer.*

Commercial feed stuffs are usually bought for their high percentage of either nitrogen-containing organic matter or fat, or both. They are used to enrich the daily diet of various kinds of farm live stock in both directions. This course is generally adopted on account of a well-known deficiency of most of our home-raised coarse fodder articles in regard to both food constituents, in particular of nitrogenous matter. Farmers that do not raise a liberal proportion of clover-like fodder plants are in a particular degree in need of concentrated commercial feed stuffs rich in nitrogenous food constituents, to turn the excess of the non-nitrogenous food constituents which most of our current home-raised coarse fodder articles contain to the best possible account.

The liability of pecuniary losses on the part of the buyer, in consequence of exceptional variations in the percentage of nitrogenous organic matter, crude protein or fat, or of both, is quite frequently greatly aggravated by most unexpected serious fluctuations in the market cost of leading feed stuffs.

As we buy in the majority of cases the concentrated commercial feed stuffs on account of their large proportion of nitrogen-containing food constituents, it becomes of special interest to know at what cost a *given quantity of nitrogen-*

containing food constituents can be bought in the form of different feed stuffs equally well adapted under existing circumstances. A change in the *market cost* of one and the same commercial feed stuff affects the cost of the nitrogen-containing food constituent in particular as its supply is more limited than that of the non-nitrogenous food constituents which our home-raised coarse fodder articles contain as a rule in abundance, and which therefore need not to be secured from outside resources for cash.

The subsequent tabular statement assumes a constant cost of digestible non-nitrogenous food constituents, — sugar, starch, fat, etc., — and shows thereby the variations in the cost of digestible nitrogen-containing food constituents, in case of some prominent concentrated commercial feed stuffs in our local market.

The majority of analyses stated are made of fodder articles which have been used either during the past year in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

Valuation of Fodder Articles on the Following Basis.

[Digestible cellulose and nitrogen-free extract matter, 1 cent per pound; digestible fat, 2½ cents per pound. The value of digestible protein determined the difference of the sum of both and the market cost of the fodder articles. (Calculation is based on dry matter, 2,000 pounds)]

	Market Cost.	Protein per Pound (Cents).
Corn meal,	$31 00	6.88
Corn meal,	29 00	5.84
Corn meal,	24 00	3.24
Corn meal,	23 00	2.72
Wheat middlings,	20 00	3.13
Spring wheat bran,	19 00	3.04
Winter wheat bran,	21 00	3.93
Chicago maize feed,	23 00	2.34
Dried brewers' grain,	22 00	3.37
Old-process linseed meal,	26 00	2.20
New-process linseed meal,	27 00	2.68
Chicago gluten meal,	28 00	2.46
Cotton-seed meal,	28 00	2.34
English hay,	12 00	1.36
English hay,	15 00	4.12
Rowen,	12 00	1.21
Rowen,	15 00	3.24
Corn stover,*	5 00	–
Corn ensilage,*	2 50	–
Mangold roots,*	3 00	–
Sugar beets,*	5 00	–

* The value of the digestible cellulose, nitrogen-free extract matter and fat, on the above basis, exceeds the market cost.

Prices are apt to rise and to fall without any reference to the agricultural value of the article in question.

Names may remain the same, and in fact do remain in some instances, while the composition of the article suffers serious changes in consequence of changes in the parent industry.

Sales without due responsibility regarding the particular quality of the goods delivered leaves the pecuniary risk involved in the transaction in an objectionable degree on the side of the buyer.

Unaccounted-for variations in the composition of feed stuffs must prove a serious obstacle in the desirable introduction of a rational and economical system of stock feeding.

For these and other reasons previously pointed out it cannot be claimed that the prevailing mode of selling and buying commercial feed stuffs rests on a just and fairly equitable basis.

The trade in commercial feed stuffs is to-day in a similar unsatisfactory condition as was the trade in commercial fertilizers before the introduction of a system of State inspection in regard to those articles.

The generally conceded success of the introduction of a well-regulated system of State inspection in regard to commercial fertilizers seems to suggest the adoption of a similar course with reference to the trade in commercial feed stuffs.

The best interests of both manufacturers and farmers, in fact of every one who keeps live stock for his accommodation, render such changes desirable in the present mode of selling and buying feed stuffs as will impose mutual and equitable responsibility on all parties interested in the transaction. The limited margins for profit in every branch of animal industry carried on at our farms necessitates a careful attention to all the details of the business. The money interests involved are of an exceptional magnitude.

A due consideration of the present condition of our trade in commercial feed stuffs has induced the Board of Control of the Massachusetts State Agricultural Experiment Station to request the writer to present the subject once more to the consideration of all parties interested; and to invite their co-operation in devising suitable means to secure a fair degree of mutual responsibility on the part of all parties interested in the trade and the consumption of commercial feed stuffs.

C. A. GOESSMANN.

NOVEMBER, 1892.

6. Analyses of Fodder Articles made at the Station in 1892.

Green Corn (1891).

[I., Pride of the North; II., Stowell's Evergreen.]

[From station barn.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	71.86	83.91
Dry matter,	28.14	16.09
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	3.78	6.73
" cellulose,	25.67	26.03
" fat,	2.24	3.26
" protein,	7.62	8.09
Non-nitrogenous matter,	60.69	55.89
	100.00	100.00

Corn Stover (1891).

[I., Pride of the North; II., Stowell's Evergreen.]

[From station barn.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	20.10	41.62
Dry matter,	79.90	58.38
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	6.12	9.76
" cellulose,	33.72	37.79
" fat,	2.51	2.44
" protein,	7.75	6.08
Non-nitrogenous matter,	49.90	43.93
	100.00	100.00

Corn Kernels (1891).

[I., Pride of the North; II., Stowell's Evergreen.]

[From station barn.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	13.68	11.98
Dry matter,	86.32	88.02
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	1.29	1.63
" cellulose,	1.69	2.41
" fat,	4.11	9.56
" protein,	10.42	12.57
Non-nitrogenous matter,	82.49	73.83
	100.00	100.00

Corn Cobs (1891).

[I., Pride of the North; II., Stowell's Evergreen.]

[From station barn.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	7.00	5.95
Dry matter,	93.00	94.05
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	1.42	2.53
" cellulose,	37.84	34.19
" fat,	0.35	0.77
" protein,	1.46	1.73
Non-nitrogenous matter,	58.83	58.78
	100.00	100.00

Stowell's Evergreen Sweet Corn (1891).

[From station barn.]

	I.	II.	III.	IV.
Ears (four): —				
Number of rows,	14	14	16	14
Moisture at 100° C.,	11.98	11.98	11.98	11.98
Total weight of ear (grams),	116.3	104.6	111.5	79.3
Weight of kernels (grams),	91.87	77.4	90.9	61.0
Per cent. of total weight,	78.99	73.99	81.52	76.92
Weight of cobs (grams),	24.43	27.2	20.6	18.3
Per cent. of total weight,	21.01	26.01	18.48	23.08

Corn Ensilage (1891).

[I., Pride of the North; II., Stowell's Evergreen.]

[From station barn.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	79.98	84.30
Dry matter,	20.08	15.70
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.99	6.32
" cellulose,	27.19	29.32
" fat,	3.29	7.36
" protein,	8.29	7.86
Non-nitrogenous matter,	56.24	49.14
	100.00	100.00
Acidity (as acetic acid),	1.18	1.33

Fertilizing Constituents.

Moisture,	79.98	84.30
Nitrogen,	0.266	0.197
Phosphoric acid,	–	0.087
Potassium oxide,	–	0.406
Valuation per 2,000 pounds,	–	$1 05

Vetch and Oats, green (1891).

[From station barn.]

	Per Cent.
Moisture at 100° C.,	57.96
Dry matter,	42.04
	100.00

Analysis of Dry Matter.

Crude ash,	7.97
" cellulose,	30.77
" fat,	2.58
" protein,	8.83
Non-nitrogenous extract matter,	49.85
	100.00

Notes on Changes in Dry Matter during Growth.

	July 7, 1891.	July 22, 1891.	Aug. 3, 1891.
Moisture at 100° C.,	79.75	64.77	57.96
Dry matter,	20.25	35.23	42.04

Soja Bean, green (1891).

[From station barn.]

	Per Cent.
Moisture at 100° C.,	72.22
Dry matter,	27.78
	100.00

Analysis of Dry Matter.

Crude ash,	6.39
" cellulose,	31.49
" fat,	3.39
" protein,	13.71
Non-nitrogenous extract matter,	45.02
	100.00

Notes on Changes in Dry Matter during Growth.

	Aug. 3, 1891.	Aug. 17, 1891.	Sept. 2, 1891.
Moisture at 100° C.,	80.24	72.22	70.22
Dry matter,	19.76	27.78	29.78

Green Rye (1892).

[From station barn.]

	Per Cent.
Moisture at 100° C.,	62.11
Dry matter,	37.89
	100.00

Analysis of Dry Matter.

Crude ash,	5.27
" cellulose,	21.52
" fat,	2.46
" protein,	5.38
Non-nitrogenous extract matter,	65.37
	100.00

Fertilizing Constituents.

Moisture,	62.11
Nitrogen,	0.327
Phosphoric acid,	0.15
Potassium oxide,	0.734
Valuation per 2,000 pounds,	$1 80

*Hungarian Grass, green * (1892).*

[From station barn.]

	Per Cent.
Moisture at 100° C.,	74.31
Dry matter,	25.69
	100.00

Analysis of Dry Matter.

Crude ash,	8.94
" cellulose,	31.23
" fat,	2.43
" protein,	9.39
Non-nitrogenous extract matter,	48.01
	100.00

Fertilizing Constituents.

Moisture,	74.31
Nitrogen,	0.385
Phosphoric acid,	0.159
Potassium oxide,	0.549
Valuation per 2,000 pounds,	$1 82

* Second crop after rye.

Green Corn Fodder (1892).

[From station barn.]

	Per Cent.
Moisture at 100° C.,	68.53
Dry matter,	31.47
	100.00

Analysis of Dry Matter.

Crude ash,	5.68
" cellulose,	22.99
" fat,	2.81
" protein,	6.22
Non-nitrogenous extract matter,	62.30
	100.00

Fertilizing Constituents.

Moisture,	68.53
Nitrogen,	0.31
Phosphoric acid,	0.055
Potassium oxide,	0.149
Valuation per 2,000 pounds,	$1 12

Corn Stover (1892).

[From station barn.]

	Per Cent.
Moisture at 100° C.,	14.66
Dry matter,	85.34
	100.00

Analysis of Dry Matter.

Crude ash,	5.49
" cellulose,	37.57
" fat,	1.82
" protein,	4.00
Non-nitrogenous extract matter,	51.02
	100.00

Fertilizing Constituents

Moisture,	14.66
Nitrogen,	0.546
Phosphoric acid,	0.228
Potassium oxide,	1.84
Valuation per 2,000 pounds,	$3 55

Soja Bean, green (1892).*

[From station barn]

	Per Cent.
Moisture at 100° C.,	73.20
Dry matter,	26.80
	100.00

Analysis of Dry Matter.

Crude ash,	6.80
" cellulose,	30.54
" fat,	2.29
" protein,	6.82
Non-nitrogenous extract matter,	53.55
	100.00

Fertilizing Constituents.

Moisture,	73.20
Nitrogen,	0.292
Phosphoric acid,	0.151
Potassium oxide,	0.531
Valuation per 2,000 pounds,	$1 52

Soja Bean Straw, Late Variety (1892).

[From station barn.]

	Per Cent.
Moisture at 100° C.,	7.63
Dry matter,	92.37
	100.00

Analysis of Dry Matter.

Crude ash,	10.72
" cellulose,	36.80
" fat,	3.49
" protein,	5.34
Non-nitrogenous extract matter,	43.65
	100.00

Fertilizing Constituents.

Moisture,	7.63
Nitrogen,	0.789
Phosphoric acid,	0.397
Potassium oxide,	1.322
Valuation per 2,000 pounds,	$4 19

* Late variety.

Cotton-seed Meal.

[I. and II. sent on from Boston, Mass.; III., IV. and V. sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.62	8.73	8.53	8.83	6.17
Dry matter,	91.38	91.27	91.47	91.17	93.83
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	6.44	5.94	7.54	4.72	5.34
" cellulose,	6.19	21.05	5.87	9.77	7.68
" fat,	10.69	6.23	11.67	9.47	14.19
" protein,	44.45	26.97	48.23	42.43	44.89
Non-nitrogenous extract matter,	32.23	39.79	26.69	33.61	27.90
	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

Moisture,	8.62	8.73	8.53	8.83	6.17
Nitrogen,	6.50	3.94	7.06	6.19	6.74
Phosphoric acid,	4.51	3.41	3.28	2.07	3.26
Potassium oxide,	1.49	1.398	1.37	1.48	1.70
Valuation per 2,000 pounds,	$25 80	$16 84	$26 02	$22 18	$25 34

Cotton-seed Meal.

[From station barn.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.05	5.69	6.81
Dry matter,	92.95	94.31	93.19
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	5.40	7.56	7.10
" cellulose,	6.15	7.76	6.54
" fat,	13.82	12.48	12.69
" protein,	38.79	43.69	44.33
Non-nitrogenous extract matter,	35.84	28.51	29.34
	100.00	100.00	100.00

Buffalo Gluten Feed.

[I. sent on from North Amherst, Mass.; II., III. and IV. from station barn.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.82	8.97	6.33	6.82
Dry matter,	91.18	91.03	93.67	93.18
	100.00	100.00	100.00	100.00
Analysis of Dry Matter.				
Crude ash,	1.12	0.77	0.95	0.83
" cellulose,	6.17	5.09	5.76	4.94
" fat,	12.86	13.46	12.99	13.03
" protein,	31.05	26.16	25.75	28.71
Non-nitrogenous extract matter,	48.80	54.52	54.55	52.49
	100.00	100.00	100.00	100.00

Gluten Feed.

[I. sent on from Amherst, Mass.; II. sent on from North Amherst, Mass.,; III. sent on from Chicago, Ill.]

	Per Cent.		
	I.	II.*	III.†
Moisture at 100° C.,	6.81	7.87	13.98
Dry matter,	93.19	92.13	86.02
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	1.81	1.97	0.75
" cellulose,	6.39	1.58	1.80
" fat,	11.73	10.48	16.34
" protein,	28.43	25.03	38.68
Non-nitrogenous extract matter,	51.64	60.94	42.43
	100.00	100.00	100.00

* Coon gluten feed. † Pope's gluten feed.

Gluten Meal.

[Sent on from Glen Cove, L. I.]

	Per Cent.
Moisture at 100° C.,	8.80
Dry matter,	91.20
	100.00

Analysis of Dry Matter.

Crude ash,	0.46
" cellulose,	6.10
" fat,	8.49
" protein,	18.18
Non-nitrogenous extract matter,	66.77
	100.00

Dick Gluten Flour.

[Sent on from North Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	7.07
Dry matter,	92.93
	100.00

Analysis of Dry Matter.

Crude ash,	0.91
" cellulose,	1.69
" fat,	17.11
" protein,	33.89
Non-nitrogenous extract matter,	46.40
	100.00

Corn Meal.

[I. sent on from Sherborn, Mass.; II. from station barn.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	12.38	13.96
Dry matter,	87.62	86.04
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	1.76	1.26
" cellulose,	1.92	1.49
" fat,	4.69	3.97
" protein,	10.83	11.11
Non-nitrogenous extract matter,	80.80	82.17
	100.00	100.00

Corn Meal.

[I., yellow corn meal; II., white corn meal; sent on from Salem, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	10.45	7.20
Dry matter,	89.55	92.80
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	0.95	2.47
" cellulose,	2.19	5.01
" fat,	4.62	11.22
" protein,	11.03	11.45
Non-nitrogenous extract matter,	81.21	69.85
	100.00	100.00

Corn Screenings.

[Sent on from Baldwinville, Mass.]

	Per Cent.
Moisture at 100° C.,	11.02
Dry matter,	88.98
	100.00
Analysis of Dry Matter.	
Crude ash,	2.39
" cellulose,	3.27
" fat,	4.48
" protein,	8.29
Non-nitrogenous extract matter,	81.57
	100.00

Corn Germ Meal.

[Sent on from Conway, Mass.]

	Per Cent.
Moisture at 100° C.,	7.55
Dry matter,	92.45
	100.00
Analysis of Dry Matter.	
Crude ash,	0.87
" cellulose,	14.05
" fat,	12.17
" protein,	10.81
Non-nitrogenous extract matter,	62.10
	100.00

Maize Feed.

[From station barn.]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	8.80	8.60
Dry matter,	91.20	91.40
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	0.65	0.92
" cellulose,	8.01	7.93
" fat,	6.84	7.90
" protein,	25.69	29.40
Non-nitrogenous extract matter,	58.81	53.85
	100.00	100.00

Wheat Bran.

[From station barn.]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	10.01	10.18
Dry matter,	89.99	89.82
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	6.58	6.65
" cellulose,	11.77	12.04
" fat,	5.04	4.49
" protein,	18.06	17.05
Non-nitrogenous extract matter,	58.55	59.77
	100.00	100.00

Starch Feed.

[I. sent on from Boston, Mass.; II. sent on from Chicago, Ill.]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	7.37	5.48
Dry matter,	92.63	94.52
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	0.62	0.90
" cellulose,	5.84	15.21
" fat,	12.35	11.30
" protein,	35.61	11.28
Non-nitrogenous extract matter,	45.48	61.31
	100.00	100.00

Oat Feed.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	9.34
Dry matter,	90.66
	100.00
Analysis of Dry Matter.	
Crude ash,	4.40
" cellulose,	8.79
" fat,	8.23
" protein,	14.06
Non-nitrogenous extract matter,	66.52
	100.00

Malt Sprouts.

[Sent on from South Acton, Mass.]

	Per Cent.
Moisture at 100° C.,	15.37
Dry matter,	84.63
	100.00
Analysis of Dry Matter.	
Crude ash,	6.31
" cellulose,	14.75
" fat,	3.85
" protein,	27.17
Non-nitrogenous extract matter,	47.92
	100.00

Ground Barley.

[From station barn.]

	Per Cent.
Moisture at 100 C.,	10.91
Dry matter,	89.09
	100.00

Analysis of Dry Matter.

Crude ash,	3.19
" cellulose,	4.10
" fat,	2.13
" protein,	13.33
Non-nitrogenous extract matter,	77.25
	100.00

Chicken Feed (Ground Meat Scraps).

[Sent on from North Hadley, Mass.]

	Per Cent.
Moisture at 100° C.,	3.71
Dry matter,	96.29
	100.00

Analysis of Dry Matter.

Crude ash,	35.61
" cellulose,	–
" fat,	20.31
" protein,	40.08
Non-nitrogenous extract matter,	–

Fertilizing Constituents.

Moisture,	3.71
Nitrogen,	6.51
Phosphoric acid,	2.29
Potassium oxide,	–

II.

FEEDING EXPERIMENTS WITH STEERS (TWO).

1889–92.

Introduction. — The two new feeding experiments briefly described within a few subsequent pages may be considered as a continuation of a preceding one, reported in full in our ninth annual report, 1891–92, pages 107 to 127. They were planned chiefly for the purpose of ascertaining *the cost of the feed for the production of beef for the meat market in case of growing steers, under existing local market conditions of the supply of coarse and fine feed stuffs and of cost of beef.*

During our first experiment in the stated direction, four young steers, grade Shorthorn, two one year old and two two years old, served for our observation. They were selected at different stages of growth, for the *special purpose of observing and comparing the feeding effect of one and the same suitable daily diet on the rate of increase in live weights* and on *the cost of the feed consumed per pound of live weight produced*, under specified conditions.

The *coarse fodder articles used on that occasion* were home raised, and consisted, from the beginning to the end of the trial, of either dry fodder corn, or corn ensilage, or corn stover, all obtained from the same variety of field corn, — Pride of the North. The corn used for the production of dry fodder corn and of corn ensilage was in both cases of a corresponding stage of growth, — kernels glazing. The corn stover was obtained from the fully matured crop.

The *fine* or *grain feed* used in that connection in the preparation of the daily fodder rations consisted, as a rule, of equal weights of either wheat bran and Chicago gluten meal, or of wheat bran and old-process linseed meal, or of wheat bran, old-process linseed meal and corn and cob meal. The total quantity of the grain feed mixture used daily, per head, varied from seven to nine pounds; it never exceeded nine pounds. The amount of coarse feed daily consumed per

head was controlled in every case by the appetite of each animal on trial. Both lots of steers were kept in the stall during the entire time occupied by the observation, — December, 1889, to April, 1890.

The most satisfactory results were noticed in case of both lots, as far as the daily increase in live weight is concerned, when corn ensilage was fed with a mixture of either wheat bran and Chicago gluten meal or of wheat bran and old-process linseed meal. During a period of from six to seven weeks, when feeding the stated feed stuffs, the daily gain in live weights in case of the yearlings reached in one instance as high as 2.9 pounds per head, while in case of the two-year-old steers it amounted under corresponding conditions to 3.45 pounds per head. The live weight of the yearlings at that time was from 650 to 700 pounds each, and that of the older steers from 1,150 to 1,200 pounds each. The *market cost* of the daily fodder rations used at the stated time averaged, per head, in case of the yearlings, 13.79 cents, and *its net* cost was 5.03 cents; while in case of the two older steers the market cost of the daily fodder rations averaged 18 cents per head, and its net cost was 7.04 cents. We paid in case of both lots of young steers $3\frac{1}{2}$ cents per pound of live weight, and sold at the close of the experiments the older lot of steers to the butcher at $3\frac{3}{4}$ cents per pound of live weight. The shrinkage noticed between live weight and dressed weight varied from 34 to 36 per cent. Dressed beef brought at that time from $5\frac{3}{4}$ to 6 cents per pound.

The financial result of the experiment, as far as the highest daily yield of live weight is concerned, at stated market price, may be seen from the following summary: —

SUMMARY.	Yearlings.	Two-year-olds.
Market cost of daily fodder rations,	13.79 cents.	18.00 cents.
Obtainable manurial value per day,	8.76 "	10.96 "
Net cost of daily fodder rations,*	5.03 "	7.04 "
Live weight produced per day,	2.99 lbs.	3.45 lbs.
Cash received for live weight produced per day,	11.21 cents.	12.97 cents.

* Allowing ninety-two per cent. of the manurial value of the feed consumed obtainable.

From these statements it will be noticed that the profit secured by the operation consisted in the value of the obtainable manure and in the disposition of our home-raised fodder articles at fair local retail selling prices. The yearlings proved more remunerative than the two-year-old steers.

Two facts were apparently fairly demonstrated by our first observation, namely: —

1. Yearlings increase at a higher rate in live weight, in case of a corresponding suitable diet, than two-year-old steers, taking the total temporary live weight of the animal on trial as the basis for the comparison. The highest daily increase in the live weight of the yearlings — 650 pounds each — amounted in our first feeding experiment to 0.46 pounds per one hundred pounds of live weight; and in that of the two-year-old steers — 1,150 pounds each — to 0.3 pounds per one hundred pounds of live weight.

2. Our local market price of young steers and of dressed beef necessitates not only an exceptional care in the selection of efficient and low-priced feed stuffs, but also a careful attention in regard to a judicious combination of suitable feed stuffs for the preparation of an economical diet, to render with us the production of beef for the meat market remunerative.

To assist in a desirable solution of that problem is the principal motive for continuing our observation in the stated direction.

Some of the leading features in the management of our *first* feeding experiment are retained in the course pursued during our *second* experiment, which is farther on briefly described. The difference between the latter and the first feeding experiment consists in the following circumstances: —

1. One set of young steers — yearlings — served from the beginning to the end of the experiment.

2. The observation extended over a period of sixteen months, including two succeeding winter seasons, with summer pasturing between them.

3. The animals were kept in the stall, practically without any out-door exercise, during the late autumn, the winter and the earlier part of the spring. During the growing season, from May to the middle of October, they were turned

for support into a good pasture; no additional food from any outside source was offered during that period.

4. A greater variety of coarse and fine fodder articles was used in the preparation of the daily diet at different stages of the experiments during the second winter season than on the preceding occasion.

Second Feeding Experiment with Steers.

December, 1889, to March, 1891.

Two one-year-old steers, grade Shorthorn, of fairly corresponding general condition, served in the trial. They were bought at $3\frac{1}{2}$ cents per pound of live weight. No. 1 weighed 675 pounds, No. 2 weighed 600 pounds, when bought. The systematic feeding began during the middle of December, 1889, both receiving as far as practicable at all times the same daily fodder rations. The mode of feeding was the same as described in the preceding experiment, — twice a day; water was offered two hours after feeding.

The grain-feed part of the daily diet was at all times a definite one, and the same in quantity and quality in case of both animals. The amount of the coarse feed consumed daily was governed by the appetite of each animal. The composition of the daily fodder rations used during the first winter season, 1889–90, differed materially from those used during the second winter season, 1890–91. This circumstance renders it advisable, in the interest of a due appreciation of the feeding results in different stages of the trial, to state our results with reference to its *three distinctly different feeding periods;* namely, feeding record of *first winter season*, of *summer pasturing* and of *second winter season.*

1. *Feeding Record of First Winter Season.*

Dec. 17, 1889, to May 9, 1890.

[Coarse fodder articles: dry fodder corn, corn ensilage, corn stover and sugar beets; fine fodder articles: wheat bran, Chicago gluten meal, old process linseed meal and corn and cob meal.]

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$16 50
Gluten meal, Chicago,	23 00
Old-process linseed meal,	27 50
Corn and cob meal,	16 50
Corn stover,	5 00
Corn ensilage,	2 75
Corn fodder,	7 50
Sugar beets,	5 00

Analyses of the Various Articles of Fodder used.

FOOD ANALYSES.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.
Moisture at 100° C.,	9.27	9.80	9.88	8.10	26.95	72.95	20.42	90.02
Dry matter,	90.73	90.20	90.12	91.90	73.05	27.05	79.58	9.98
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.								
Crude ash,	7.47	1.25	7.39	1.47	5.80	6.48	7.40	11.84
" cellulose,	9.75	1.75	8.74	5.63	34.33	26.33	20.11	8.20
" fat,	5.48	7.00	7.24	3.73	1.66	5.17	1.65	0.71
" protein,	17.53	31.25	36.97	9.79	7.90	7.64	8.31	11.53
Non-nitrogenous extract matter,	59.77	58.75	39.66	79.38	50.31	54.38	62.53	67.72
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.
Moisture,	9.27	9.80	9.88	8.10	26.95	72.95	20.42	90.02
Nitrogen,	2.545	4.510	5.331	1.439	0.923	0.330	1.058	0.184
Phosphoric acid,	2.900	0.392	1.646	0.603	0.303	1.138	0.510	0.086
Potassium oxide,	1.637	0.049	1.162	0.441	1.320	0.301	0.760	0.462
Valuation per 2,000 pounds,	$13 60	$16 18	$21 15	$6 02	$4 69	$1 56	$4 89	$1 14

Average Composition of the Daily Fodder Rations used during the Six Successive Feeding Periods (First Winter Season, 1889–90).

I.

December 17 to December 31.

Wheat bran (pounds),	2.25
Gluten meal (pounds),	2.25
Corn stover (pounds),	12.00
Nutritive ratio,	1 : 5.51
Total cost (cents),	7.45
Manurial value obtainable (cents),	5.68
Net cost (cents),	1.77

II.

January 4 to January 22.

Wheat bran (pounds),	3.88
Gluten meal (pounds),	3.88
Corn ensilage (pounds),	37.50
Nutritive ratio,	1 : 5.49
Total cost (cents),	12.82
Manurial value obtainable (cents),	8.01
Net cost (cents),	4.81

III.

January 28 to February 16.

Wheat bran (pounds),	4.00
Old-process linseed meal (pounds),	4.00
Corn ensilage (pounds),	43.38
Nutritive ratio,	1 : 5.69
Total cost (cents),	14.76
Manurial value obtainable (cents),	9.50
Net cost (cents),	5.26

IV.

February 21 to March 11.

Wheat bran (pounds),	3.00
Old-process linseed meal (pounds),	3.00
Corn and cob meal (pounds),	3.00
Corn fodder (pounds),	9.00
Nutritive ratio,	1 : 4.93
Total cost (cents),	12.45
Manurial value obtainable (cents),	7.65
Net cost (cents),	4.80

V.

March 14 to April 21.

Wheat bran (pounds),	3.00
Old-process linseed meal (pounds),	3.00
Corn and cob meal (pounds),	3.00
Corn stover (pounds),	6.00
Nutritive ratio,	1 : 4.55
Total cost (cents),	10.58
Manurial value obtainable (cents),	6.92
Net cost (cents),	3.66

VI.

April 24 to May 9.

Wheat bran (pounds),	3.00
Old-process linseed meal (pounds),	3.00
Corn and cob meal (pounds),	3.00
Corn stover (pounds),	3.60
Sugar beets (pounds),	20.00
Nutritive ratio,	1 : 4.49
Total cost (cents),	14.98
Manurial value obtainable (cents),	7.44
Net cost (cents),	7.54

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
Total cost, ...	7.45	12.82	14.76	12.45	10.58	14.98
Manurial value obtainable, .	5.68	8.01	9.50	7.65	6.92	7.44
Net cost,*	1.77	4.81	5.26	4.80	3.66	7.54

* Allowing ninety-two per cent. of the manurial value of the feed consumed obtainable.

As the selling price of live weight per pound of matured steers was $3\frac{3}{4}$ cents, it will be found that, to cover the daily expenses for feed consumed in form of the six stated average daily fodder rations, the following rate of a daily increase, per head, in pounds of live weight, becomes necessary: —

Gain required in Pounds, per Day, of Live Weight, to cover Expenses for Feed.

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
On total cost, ...	1.99	3.42	3.93	3.32	2.82	3.99
On net cost, ...	0.47	1.28	1.40	1.28	0.98	2.01

To what extent the various fodder rations have secured the above-specified increase in live weight may be seen from the subsequent detailed feeding record of each steer on trial: —

Steer No. 1 (Yearling).

FEEDING PERIODS.	Feed consumed (Pounds) per Day.								Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.					
1889-90.													
Dec. 17 to Dec. 31,	2.27	2.33	–	–	5.27	–	–	–	7.82	1:4.63	675	654	-1.40
Jan. 4 to Jan. 22,	3.88	3.88	–	–	–	37.89	–	–	16.72	1:5.51	667	708	2.16
Jan. 28 to Feb. 16,	4.00	–	4.00	–	–	42.20	–	–	19.30	1:5.63	725	783	2.90
Feb. 21 to March 11,	3.00	–	3.00	3.00	–	–	9.42	–	15.68	1:4.98	785	820	1.84
March 14 to April 21,	3.00	–	3.00	3.00	5.91	–	–	–	12.50	1:4.54	828	880	1.33
April 24 to May 9,	3.00	–	3.00	3.00	3.50	–	–	20.00	12.74	1:4.47	882	895	0.81

	Pounds.
Live weight of animal at the beginning of the experiment,	675.00
Live weight of animal at the close of the experiment,	895.00
Live weight gained during the experiment,	220.00
Average gain in weight per day (entire experiment),	1.53
Highest average gain in live weight per day, III. period,	2.90
Lowest average gain in live weight per day, I. period,	-1.40

Steer No. 2 (Yearling).

Feeding Periods.	Feed consumed (Pounds) per Day.								Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Gluten Meal.	Old-process Linseed Meal.	Corn and Cob Meal.	Corn Stover.	Corn Ensilage.	Corn Fodder.	Sugar Beets.					
1889-90.													
Dec 17 to Dec. 31,	2.00	2.07	–	–	5.27	–	–	–	6.53	1 : 4.76	600	590	–0.67
Jan. 4 to Jan. 22,	3.88	3.88	–	–	–	37.32	–	–	16.54	1 : 5.47	610	674	3.37
Jan. 28 to Feb. 16,	4.00	–	4.00	–	–	44.55	–	–	19.97	1 : 5.75	680	745	3.25
Feb. 21 to March 11,	3.00	–	3.00	3.00	–	–	8.53	–	14.97	1 : 4.87	746	770	1.26
March 14 to April 21,	3.00	–	3.00	3.00	6.00	–	–	–	12.56	1 : 4.55	776	826	1.28
April 24 to May 9,	3.00	–	3.00	3.00	3.69	–	–	20.00	12.88	1 : 4.50	828	840	0.75

	Pounds.
Live weight of animal at the beginning of the experiment,	600.00
Live weight of animal at the close of the experiment,	840.00
Live weight gained during the experiment,	240.00
Average gain in weight per day (entire experiment),	1.07
Highest average gain in live weight per day, II. period,	3.37
Lowest average gain in live weight per day, I. period,	–0.67

The first feeding period in case of both animals shows a decided loss in live weight; this result is presumably largely due to the influence of an entire change in mode of keeping and feeding, and cannot be charged to the daily diet.

2. *Record of Summer Pasturing.*

May 10, 1890, to Sept. 30, 1890.

	No. 1.	No. 2.
Date of turning steers into pasture,	May 10, 1890.	May 10, 1890.
Date of closing pasturing,	Sept. 30, 1890.	Sept. 30, 1890.
Number of days of pasturing,	144	144
Live weight of steers when turned into pasture,	895 lbs.	840 lbs.
Live weight of steers at close of pasturing,	1,020 "	923 "
Total weight gain during pasturing,	125 "	83 "
Average gain in weight per day,	0.87 "	0.58 "
Cost of feed per day, allowing forty cents per week for use of pasture,	5.71 cts.	5.71 cts.
Cost of feed per pound of live weight gained,	6.58 "	9.91 "

To meet the expenses for the use of the pasture, per head, forty cents a week, requires a daily increase in live weight of 1.52 pounds, or about twice as much as we actually secured. The daily increase in live weight no doubt varies during the season more or less, in consequence of changes in the weather and in the condition of the pasture. A mere statement of the final results at the close of the season does not show the degree of temporary adverse influence. Aside from these circumstances, there is, however, another serious source of loss in live weight; apparently unavoidably connected with a system of changing from stall feeding to pasturing, and from the latter again to stall feeding. The loss in

live weight due to these changes amounted in our case to from twenty to twenty-five pounds, per head, on each occasion and in case of both animals.

3. Feeding Record of Second Winter Season.

Oct. 14, 1890, to March 3, 1891.

[Coarse fodder articles: upland meadow hay, barley straw, clover hay, corn ensilage, turnips; fine fodder articles: barley meal, wheat bran, cotton-seed meal.]

The steers, upon returning from the pasture, September 30, were allowed for a week or more, some hours every day, an out-door exercise, to make the change for a subsequent close confinement and a systematic system of feeding a gradual one. The mode of feeding was the same as during the preceding winter season. The daily grain-feed rations consisted either of wheat bran and cotton-seed meal, 3.5 pounds each, per head, or of wheat bran, barley meal and cotton-seed meal, varying from 3 to 3.5 pounds each, per head, at different times. The daily coarse-feed ration consisted at different times in varying proportions either of English hay, or of English hay and barley straw, or of English hay, clover hay and turnips, or of clover hay and corn ensilage; the amount consumed was controlled by the appetite of each animal on trial. The subsequent detailed statement of fodder rations used represents in each case the average composition of the daily diet during succeeding feeding periods. The change from one daily diet to another is in all cases a gradual one, to avoid as far as practicable serious disturbances in digestion.

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$23 50
Barley meal,	30 00
Cotton-seed meal,	27 50
Barley straw,	5 00
Hay,	15 00
Clover hay,	12 00
Turnips,	4 00
Corn ensilage,	2 75

Analyses of the Various Articles of Fodder used.

Food Analyses.	Wheat Bran.	Barley Meal.	Cotton-seed Meal.	Barley Straw	Hay.	Clover Hay.	Turnips.	Corn Ensilage.
Moisture at 100° C.,	12.11	14.62	10.13	11.44	9.72	17.41	89.32	80.53
Dry matter,	87.89	85.38	89.87	88.56	90.28	82.59	10.68	19.47
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.								
Crude ash,	7.40	3.18	8.22	5.30	6.43	14.98	9.54	6.73
" cellulose,	12.17	5.04	7.26	33.85	32.28	30.37	12.61	26.90
" fat,	5.04	2.38	11.64	3.38	2.49	1.75	2.05	3.27
" protein,	18.48	14.93	45.99	9.24	9.54	16.64	9.89	8.97
Non-nitrogenous extract matter,	56.91	74.47	26.89	48.23	49.26	36.26	65.91	54.13
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Barley Meal	Cotton-seed Meal.	Barley Straw.	Hay.	Clover Hay.	Turnips.	Corn Ensilage.
Moisture,	12.11	14.62	10.13	11.44	9.72	17.41	89.32	80.53
Nitrogen,	2.697	2.04	6.613	1.310	1.379	2.20	1.69	0.279
Phosphoric acid,	2.870	0.660	2.090	0.303	0.352	0.603	0.092	0.096
Potassium oxide,	1.620	0.341	1.620	2.086	1.541	1.962	0.358	0.226
Valuation per 2,000 pounds,	$12 71	$7 16	$23 60	$6 14	$5 92	$9 03	$0 93	$1 15

Average Composition of the Daily Fodder Rations used during the Six Successive Feeding Periods (Second Winter Season, 1890–91).

I. *October 14 to October 25.*

Wheat bran (pounds),	3.50
Cotton-seed meal (pounds),	3.50
Barley straw (pounds),	6.42
Hay (pounds),	8.33
Nutritive ratio,	1 : 4.15
Total cost (cents),	16.78
Manurial value obtainable (cents),	9.93
Net cost (cents),	6.85

II. *October 28 to November 10.*

Wheat bran (pounds),	3.50
Cotton-seed meal (pounds),	3.50
Hay (pounds),	15.68
Nutritive ratio,	1 : 4.08
Total cost (cents),	20.68
Manurial value obtainable (cents),	10.11
Net cost (cents),	10.57

III. *November 13 to December 1.*

Wheat bran (pounds),	2.50
Cotton-seed meal (pounds),	3.50
Hay (pounds),	7.53
Clover hay (pounds),	7.72
Turnips (pounds),	30.00
Nutritive ratio,	1 : 3.75
Total cost (cents),	25.2
Manurial value obtainable (cents),	12.38
Net cost (cents),	12.82

IV. *December 2 to December 15.*

Wheat bran (pounds),	2.50
Barley meal (pounds),	2.50
Cotton-seed meal (pounds),	2.50
Hay (pounds),	7.04
Clover hay (pounds),	6.15
Turnips (pounds),	30.00
Nutritive ratio,	1 : 4.28
Total cost (cents),	25.10
Manurial value obtainable (cents),	10.75
Net cost (cents),	14.35

V. *December 16 to January 19.*

Wheat bran (pounds),	3.32
Barley meal (pounds),	3.32
Cotton-seed meal (pounds),	3.32
Hay (pounds),	6.44
Clover hay (pounds),	5.34
Turnips (pounds),	30.00
Nutritive ratio,	1 : 4.01
Total cost (cents),	27.48
Manurial value obtainable (cents),	11.89
Net cost (cents),	15.59

VI. *January 27 to March 2.*

Wheat bran (pounds),	3.00
Barley meal (pounds),	3.00
Cotton-seed meal (pounds),	3.00
Clover hay (pounds),	5.07
Corn ensilage (pounds),	42.45
Nutritive ratio,	1 : 4.11
Total cost (cents),	21.05
Manurial value obtainable (cents),	10.34
Net cost (cents),	10.71

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
Total cost, . . .	16.78	20.68	25.20	25.10	27.48	21.05
Manurial value obtainable, ...	9.93	10.11	12.38	10.75	11.89	10.34
Net cost,* . . .	6.85	10.57	12.82	14.35	15.59	10.71

* Allowing ninety-two per cent. of the manurial value of the feed consumed obtainable.

Taking the selling price of dressed beef at $3\frac{3}{4}$ cents per pound, it follows that, to cover the daily expenses for feed consumed in the form of the above specified six daily fodder rations, the following rate of daily increase in pounds of live weight becomes necessary : —

Gain required in Pounds, per Day, of Live Weight, to cover Expenses for Feed.

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
On total cost, . .	4.47	5.51	6.72	6.69	7.33	5.61
On net cost, . . .	1.83	2.82	3.42	3.83	4.16	2.86

The subsequent detailed record of each steer on trial shows to what extent each of the previously specified fodder rations has realized the required increase in live weight.

Conclusions.

1. The rate of increase in live weight was highest during the first winter season, 1889–90. The daily increase in live weight averaged in case of steer No. 1, 2.5 pounds, and in the case of steer No. 2, 3.3 pounds, for a period of six weeks, when fodder rations II. and III. were fed. The market value of the stated daily increase in live weight, at $3\frac{3}{4}$ cents per pound, would amount to 9.4 cents in case of steer No. 1, and to 12.4 cents in case of steer No. 2. As the market cost of these two fodder rations averages 13.8 cents and

their net cost 5.03 cents, it will be noticed that the value gained by the stated increase in live weight does in neither case pay fully for the food consumed for its production; yet there remains a noticeable margin of profit on the net cost of the daily feed in the form of obtainable manure; *i. e.*, 4.37 cents per day in case of steer No. 1, and 7.37 cents in case of steer No. 2.

2. The average of the daily increase in the live weight of the steers during the entire period of pasture feeding amounted, in case of steer No. 1, to .87 pounds, and in the case of steer No. 2 to .58 pounds. This increase in live weight represents on an average a market value of 3.18 cents in case of the former, and in that of the latter of 2.18 cents. Our expenses for the use of the pasture, per head, was 40 cents per week, or 5.7 cents per day. We lost, per head, 3 cents per day, or 21 cents per week, on each animal; not counting expenses for transportation to and from the pasture, loss of interest on the investment, etc.

3. The financial results of the second winter feeding are less satisfactory than those secured during the first winter feeding. This fact is due to two circumstances, namely, higher market cost of several coarse and fine fodder articles used, and less nutritive effect of the fodder rations experimented with. The daily increase in live weight did at no time exceed 2.33 pounds per head. The market cost of the various daily fodder rations used during the time stated varied from 16.8 cents to 27.48 cents per head, while their net cost differed from 6.85 cents to 15.59 cents. The highest temporary increase in live weight noticed, per day, 2.33 pounds, would realize in our market only 12.37 cents, which amount is still 4.5 cents less than the market cost of the cheapest daily fodder ration, I. period, used.

The results of the second feeding experiment emphasize the statements made in connection with the report of our first experiment, namely, cheaper and more efficient fodder rations than most of our grass lands — meadows and pastures — can furnish have to be devised to render the production of beef for our meat markets remunerative.

Our observations with growing steers have been continued, and feeding experiments carried on without the assistance of summer pasturing are well advanced.

Steer No. 1.

Feeding Periods.	Feed consumed (Pounds) per Day.								Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Barley Meal.	Cotton-seed Meal.	Barley Straw.	Hay.	Clover Hay.	Turnips.	Corn Ensilage.					
1890-91.													
Oct. 14 to Oct. 25,	3.50	–	3.50	7.00	8.33	–	–	–	19.96	1:4.22	1,060	1,085	2.08
Oct. 28 to Nov. 10,	3.50	–	3.50	–	16.53	–	–	–	21.16	1:4.16	1,095	1,083	-0.75
Nov. 13 to Dec. 1,	3.50	–	3.50	–	8.00	8.10	30.00	–	23.35	1:3.78	1,096	1,140	2.32
Dec. 2 to Dec. 15,	2.50	2.50	2.50	–	8.00	7.00	30.00	–	22.79	1:4.34	1,140	1,165	1.79
Dec. 16 to Jan. 19,	3.50	3.50	3.50	–	7.13	6.14	30.00	–	23.94	1:3.99	1,165	1,238	2.09
Jan. 27 to March 2,	3.00	3.00	3.00	–	–	4.91	–	49.40	21.59	1:4.28	1,240	1,320	2.29

	Pounds.
Weight of animal at the beginning of the experiment,	1,020.00
Weight of animal at the time of killing,	1,328.00
Live weight gained during the experiment,	308.00
Average gain in weight per day (entire experiment),	1.90
Highest average gain in live weight per day, III. period,	2.32
Lowest average gain in live weight per day, II. period,	-0.75

Steer No. 2.

Feeding Periods.	Feed consumed (Pounds) per Day.								Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Barley Meal.	Cotton-seed Meal.	Barley Straw.	Hay.	Clover Hay.	Turnips.	Corn Ensilage.					
1890-91.													
Oct. 14 to Oct. 25,	3.50	–	3.50	5.83	8.33	–	–	–	18.92	1 : 4.07	980	1,008	2.33
Oct. 28 to Nov. 10,	3.50	–	3.50	–	14.82	–	–	–	19.62	1 : 4.00	1,018	1,012	-0.43
Nov. 13 to Dec. 1,	3.50	–	3.50	–	7.05	7.34	30.00	–	21.86	1 : 3.72	1,022	1,040	0.95
Dec. 2 to Dec. 15,	2.50	2.50	2.50	–	6.07	5.29	30.00	–	19.64	1 : 4.23	1,040	1,053	0.93
Dec. 16 to Jan. 19,	3.14	3.14	3.14	–	5.74	4.54	30.00	–	20.41	1 : 4.02	1,053	1,120	1.91
Jan. 27 to March 2,	3.00	3.00	3.00	–	–	5.23	–	35.50	19.14	1 : 3.93	1,125	1,155	0.85

	Pounds.
Weight of animal at the beginning of the experiment,	923.00
Weight of animal at the time of killing,	1,154.00
Live weight gained during the experiment,	231.00
Average gain in weight per day (entire experiment),	1.43
Highest average gain in live weight per day, I. period,	2.33
Lowest average gain in live weight per day, II. period,	-0.43

Third Feeding Experiment with Steers.

October, 1890, to May, 1892.

Three one-year-old steers, grade Shorthorn, were selected for the trial. They were bought at 3½ cents per pound of live weight on Oct. 14, 1890. No. 1 weighed 655 pounds, No. 2 weighed 595 pounds and No. 3 weighed 629 pounds.

The mode of feeding and the general management of the third experiment corresponded in all essentials with the course adopted in the second feeding experiment, previously described. The third experiment is divided, as the second, and for similar reasons, into three distinctly different stages of progress, namely, *feeding record* of *first winter season*, of *summer pasturing* and of *second winter season.*

1. *Feeding Record of First Winter Season.*

Oct. 14, 1890, to April 20, 1891.

[Coarse fodder articles: upland meadow hay, barley straw, clover hay, corn ensilage and turnips; fine fodder articles: wheat bran and cotton-seed meal.]

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$23 50
Cotton-seed meal,	27 50
Barley straw,	5 00
Hay,	15 00
Mixed fodder,	12 00
Turnips,	7 00
Corn ensilage,	2 75

Analyses of the Various Articles of Fodder used.

Food Analyses.	Wheat Bran.	Cotton-seed Meal.	Barley Straw.	Hay.	Mixed Fodder.	Turnips.	Corn Ensilage.
Moisture at 100° C.,	12.11	10.13	11.44	9.72	17.41	89.32	80.53
Dry matter,	87.89	89.87	88.56	90.28	82.59	10.68	19.47
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	7.40	8.22	5.30	6.43	14.98	9.54	6.73
" cellulose,	12.17	7.26	33.85	32.28	30.37	12.61	26.90
" fat,	5.04	11.64	3.38	2.49	1.75	2.05	3.27
" protein,	18.48	45.99	9.24	9.54	16.64	9.89	8.97
Non-nitrogenous extract matter,	56.91	26.89	48.23	49.26	36.26	65.91	54.13
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Cotton-seed Meal.	Barley Straw.	Hay.	Mixed Fodder.	Turnips.	Corn Ensilage.
Moisture,	12.11	10.13	11.44	9.72	17.41	89.32	80.53
Nitrogen,	2.60	6.613	1.31	1.379	2.20	0.169	0.279
Phosphoric acid,	2.87	2.09	0.303	0.352	0.603	0.092	0.096
Potassium oxide,	1.62	1.62	2.086	1.541	1.962	0.358	0.226
Valuation per 2,000 pounds,	$12 42	$23 60	$6 14	$5 92	$9 03	$0 93	$1 15

Average Composition of the Daily Fodder Rations used during the Seven Successive Feeding Periods (First Winter Season, 1890–91).

I.		II.	
October 14 to October 25.		*October 28 to November 10.*	
Wheat bran (pounds),	2.00	Wheat bran (pounds),	2.00
Cotton-seed meal (pounds),	2.00	Cotton-seed meal (pounds),	2.00
Barley straw (pounds),	4.67	Hay (pounds),	11.50
Hay (pounds),	5.95	Nutritive ratio,	1 : 4.48
Nutritive ratio,	1 : 4.56	Total cost (cents),	13.73
Total cost (cents),	10.73	Manurial value obtainable (cents),	6.47
Manurial value obtainable (cents),	6.27	Net cost (cents),	7.26
Net cost (cents),	4.46		

III.		IV.	
November 13 to December 15.		*December 16 to January 19.*	
Wheat bran (pounds),	2.00	Wheat bran (pounds),	3.00
Cotton-seed meal (pounds),	2.00	Cotton-seed meal (pounds),	3.00
Hay (pounds),	5.43	Hay (pounds),	5.08
Mixed fodder (pounds),	5.66	Mixed fodder (pounds),	4.83
Turnips (pounds),	20.00	Turnips (pounds),	20.00
Nutritive ratio,	1 : 3.94	Nutritive ratio,	1 : 3.51
Total cost (cents),	16.57	Total cost (cents),	18.36
Manurial value obtainable (cents),	8.02	Manurial value obtainable (cents),	9.26
Net cost (cents),	8.55	Net cost (cents),	9.10

Average Composition, etc. — Concluded.

V.		VI.	
January 27 to March 6.		*March 10 to March 24.*	
Wheat bran (pounds), . .	3.00	Wheat bran (pounds), . .	3.00
Cotton-seed meal (pounds),	3.00	Cotton-seed meal (pounds),	3.00
Mixed fodder (pounds), .	5.33	Hay (pounds), ...	6.84
Corn ensilage (pounds), .	33.25	Mixed fodder (pounds), .	6.52
Nutritive ratio, . . .	1:3.46	Nutritive ratio, . . .	1:3.24
Total cost (cents), . .	15.44	Total cost (cents), . .	16.66
Manurial value obtainable (cents), ...	8.99	Manurial value obtainable (cents), ...	9.52
Net cost (cents), ...	6.45	Net cost (cents), ...	7.14

VII.	
March 25 to April 20.	
Wheat bran (pounds), ...	5.00
Cotton-seed meal (pounds), ...	3.00
Hay (pounds), ...	11.00
Nutritive ratio, ...	1:3.78
Total cost (cents), ...	16.69
Manurial value obtainable (cents), ...	9.58
Net cost (cents), ...	7.11

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.						
	I.	II.	III.	IV.	V.	VI.	VII.
Total cost, .	10.73	13.73	16.57	18.36	15.44	16.66	16.69
Manurial value obtainable, .	6.27	6.47	8.02	9.26	8.99	9.52	9.58
Net cost,* .	4.46	7.26	8.55	9.10	6.45	7.14	7.11

* Allowing ninety-two per cent. of the manurial value of the feed consumed obtainable.

Accepting as basis of calculation the selling price of dressed beef, $3\frac{3}{4}$ cents per pound, it will be noticed that, to cover the daily expenses for feed consumed in form of the previously specified seven daily fodder rations, the following rates in the daily increase in pounds of live weight become necessary: —

Gain required in Pounds, per Day, of Live Weight, to cover Expenses for Feed.

	Feeding Periods.						
	I.	II.	III.	IV.	V.	VI.	VII.
On total cost, . .	2.86	3.66	4.42	4.89	4.12	4.44	4.45
On net cost, . .	1.19	1.93	2.28	2.43	1.72	1.90	1.90

The following detailed record of each steer on trial shows to what extent each of the previously described fodder rations has materialized the necessary increase in live weight: —

Steer No. 1 (*Yearling*).

Feeding Periods.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Cotton-seed Meal.	Barley Straw.	Hay.	Mixed Fodder.	Turnips.	Corn Ensilage.					
1890-91.												
Oct. 14 to Oct. 25,	2.00	2.00	5.00	6.33	–	–	–	13.71	1 : 4.68	655	685	2.50
Oct. 28 to Nov. 10,	2.00	2.00	–	11.46	–	–	–	13.92	1 : 4.47	693	692	-0.07
Nov. 13 to Dec. 15,	2.00	2.00	–	5.27	5.42	20.00	–	14.95	1 : 3.93	697	746	2.50
Dec. 16 to Jan. 19,	3.00	3.00	–	5.06	5.23	20.00	–	16.38	1 : 3.51	746	784	1.09
Jan. 27 to March 6,	3.00	3.00	–	–	5.33	–	34.46	16.46	1 : 3.62	788	825	0.95
March 10 to March 24,	3.00	3.00	–	5.87	6.43	–	–	15.96	1 : 3.13	822	851	1.93
March 25 to April 20,	5.00	3.00	–	10.57	–	–	–	16.66	1 : 3.74	851	853	0.07

	Pounds.
Live weight of animal at the beginning of the experiment,	655.00
Live weight of animal at the close of the experiment,	853.00
Live weight of animal gained during the experiment,	198.00
Average gain of weight per day (entire experiment),	1.05
Highest average gain in live weight per day, I. period,	2.50
Lowest average gain in live weight per day, II. period,	–0.07

Steer No. 2 (Yearling).

Feeding Periods.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Cotton-seed Meal.	Barley Straw.	Hay.	Mixed Fodder.	Turnips.	Corn Ensilage.					
1890-91.												
Oct. 14 to Oct. 25,	2.00	2.00	3.88	5.42	–	–	–	11.90	1:4.31	593	602	0.75
Oct. 28 to Nov. 10,	2.00	2.00	–	10.61	–	–	–	13.15	1:4.35	605	630	1.79
Nov. 13 to Dec. 15,	2.00	2.00	–	5.29	5.45	20.00	–	15.00	1:3.93	633	690	1.73
Dec. 16 to Jan. 19,	3 00	3.00	–	5.11	4.11	20.00	–	15.49	1:3.52	690	735	1.29
Jan. 27 to March 6,	3.00	3.00	–	–	5.27	–	29.51	15.45	1:3.10	755	798	1.10
March 10 to March 24,	3.00	3.00	–	7.13	5.73	–	–	16.52	1:3.28	794	838	2.93
March 25 to April 20,	5.00	3.00	–	10.41	–	–	–	16.52	1:3.72	838	843	0.19

	Pounds.
Live weight of animal at the beginning of the experiment,	593.00
Live weight of animal at the close of the experiment,	843.00
Live weight gained during the experiment,	250.00
Average gain in weight per day (entire experiment),	1.32
Highest average gain in live weight per day, VI. period,	2.93
Lowest average gain in live weight per day, VII. period,	0.19

Steer No. 3 (Yearling).

Feeding Periods.	Feed consumed (Pounds) per Day. Wheat Bran.	Cotton-seed Meal.	Barley Straw.	Hay.	Mixed Fodder.	Turnips.	Corn Ensilage.	Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1890-91.												
Oct. 14 to Oct. 25,	2.00	2.00	5.13	6.12	–	–	–	13.64	1:4.68	626	647	1.75
Oct. 28 to Nov. 10,	2.00	2.00	–	12.54	–	–	–	14.89	1:4.62	655	675	1.43
Nov. 13 to Dec. 15,	2.00	2.00	–	5.73	6.12	20.00	–	15.93	1:3.97	681	715	1.03
Dec. 16 to Jan. 19,	3.00	3.00	–	5.00	5.14	20.00	–	16.25	1:3.50	715	760	1.29
Jan. 27 to March 6,	3.00	3.00	–	–	5.38	–	35.67	16.73	1:3.66	741	836	2.44
March 10 to March 24,	3.00	3.00	–	7.53	7.40	–	–	18.26	1:3.32	830	878	3.20
March 25 to April 20,	5.00	3.00	–	11.80	–	–	–	17.77	1:3.87	878	870	-0.30

	Pounds.
Live weight of animal at the beginning of the experiment,	626.00
Live weight of animal at the close of the experiment,	870.00
Live weight gained during the experiment,	244.00
Average gain in weight per day (entire experiment),	1.29
Highest average gain in live weight per day, VI. period,	3.20
Lowest average gain in live weight per day, VII. period,	-0.30

2. *Record of Summer Pasturing.*

April 27, 1891, to Nov. 3, 1891.

	No. 1.	No. 2.	No. 3.
Date of turning steers into pasture,	April 27, 1891.	April 27, 1891.	April 27, 1891.
Date of closing pasturing,	Nov. 3, 1891.	Nov. 3, 1891.	Nov. 3, 1891.
Number of days of pasturing,	190	190	190
Live weight of steers when turned into pasture,	830 lbs.	805 lbs.	848 lbs.
Live weight of steers at close of pasturing,	925 "	926 "	955 "
Total weight gained during pasturing,	95 "	121 "	107 "
Average gain in weight per day,	0.50 "	0.64 "	0.56 "
Cost of feed, allowing twenty-five cents per week for use of pasture,	$6 78	$6 78	$6 78
Cost of feed per pound of live weight gained,	7.14 cts.	5.60 cts.	6.33 cts.

The average gain in live weight per day, per head, was 0.95 pounds. To meet the expenses for the use of the pasture, which was 25 cents, per head, for the week, requires an increase in live weight of one pound, leaving our outlay for moving the steers to the pasture and back again without a return. Adding to this result the unavoidable falling off in live weight, due to a change in mode of living, it is apparent that pasturing without an additional supply of feed from outside sources is apt to prove an unprofitable delay in the maturing of young steers for the meat market.

To demonstrate, if possible, the correctness of this view, our more recent experiments with feeding young steers for the meat market are carried on without the assistance of the pasture. The animal is fed in the stable during the entire experiment, without any out-door exercise beyond the requirements of good health.

3. *Feeding Record of Second Winter Season.*

Nov. 10, 1891, to May 16, 1892.

[Coarse fodder articles: upland meadow hay, dent corn ensilage, sweet corn ensilage, corn stover, sugar beets, globe mangolds and turnips; fine fodder articles: wheat bran, maize feed (Chicago) and gluten feed (Buffalo).]

The steers returning from the pasture November 3, were for a week allowed out-door exercise between the times of feeding, to make the change for subsequent close confinement a gradual one.

The system of feeding remained materially the same as on previous occasion. The daily ration of grain feed was a definite one for each period, and the same in quantity for each animal at the time. It consisted during the first five periods of equal weights of wheat bran and Chicago maize feed, from 3.44 to 4 pounds each, and during the last feeding period (VI.) of equal weights of wheat bran and Buffalo gluten feed, 4 pounds each, per head, daily. The daily coarse fodder ration consisted at different times of either English hay with roots, or of corn ensilage. The amount of roots was a definite one, and the same in case of all animals; while the daily amount of hay and of corn ensilage consumed was controlled by the appetite of each steer.

The following detailed description of the six fodder rations fed during the succeeding feeding periods represents the average composition of the daily diet. Changes from one diet to another were made gradually for obvious reasons, allowing six days to pass by before recording results.

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$22 00
Maize feed,	25 00
Gluten feed,	23 00
Hay,	15 00
Turnips,	2 50
Globe mangolds,	4 00
Dent corn ensilage,	2 50
Sweet corn ensilage,	2 50
Corn stover,	5 00
Sugar beets,	5 00

Analyses of Fine Feed used.

[Grain Feed]

Food Analyses.	Wheat Bran.	Maize Feed.	Gluten Feed.
Moisture at 100° C.,	10.01	8.70	8.97
Dry matter,	89.99	91.30	91.03
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	6.58	0.78	0.77
" cellulose,	11.77	7.97	5.09
" fat,	5.04	7.37	13.46
" protein,	18.06	27.55	26.16
Non-nitrogenous extract matter,	58.55	56.33	54.52
	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Maize Feed.	Gluten Feed.
Moisture,	10.01	8.70	8.97
Nitrogen,	2.60	4.03	3.81
Phosphoric acid,	2.85	0.70	0.69
Potassium oxide,	1.63	0.43	0.42
Valuation per 2,000 pounds,	$12 40	$13 25	$12 57

Analyses of Coarse Fodder Articles used.

Food Analyses.	Hay.	Turnips.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Corn Stover.	Sugar Beets.
Moisture at 100° C.,	9.72	90.21	87.75	79.92	84.30	20.10	85.27
Dry matter,	90.28	9.79	12.25	20.08	15.70	79.90	14.73
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.43	8.47	9.06	4.99	6.32	6.12	5.95
" cellulose,	32.28	11.23	7.94	27.19	29.32	33.72	6.49
" fat,	2.49	1.74	0.88	3.29	7.36	2.51	0.66
" protein,	9.54	10.12	10.37	8.29	7.86	7.75	10.97
Non-nitrogenous extract matter,	49.26	68.44	71.75	56.24	49.14	49.90	75.93
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Hay.	Turnips.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Corn Stover.	Sugar Beets.
Moisture,	9.72	90.21	87.75	79.92	84.30	20.10	85.27
Nitrogen,	1.38	0.178	0 203	0.27	0.20	0.99	0.26
Phosphoric acid,	0.36	0.104	0.093	0.14	0.089	0.29	0.10
Potassium oxide,	1 57	0.385	0.383	0.33	0 41	1.40	0.48
Valuation per 2,000 pounds,	$5 95	$0 99	$1 06	$1 26	$1 06	$4 55	$1 32

Average Composition of the Daily Fodder Rations used during the Six Successive Feeding Periods (Second Winter Season, 1891–92).

I.		II.	
November 10 to December 22.		*December 29 to January 30.*	
Wheat bran (pounds),	3.44	Wheat bran (pounds),	4.00
Maize feed (pounds),	3.44	Maize feed (pounds),	4.00
Hay (pounds),	11.03	Hay (pounds),	9.17
Turnips (pounds),	17.38	Globe mangolds (pounds),	15.00
Nutritive ratio,	1:5.83	Nutritive ratio,	1:5.42
Total cost (cents),	18.53	Total cost (cents),	19.28
Manurial value obtainable (cents),	7.87	Manurial value obtainable (cents),	7.95
Net cost (cents),	10.66	Net cost (cents),	11.33

III.		IV.	
January 19 to February 23.		*March 1 to March 23.*	
Wheat bran (pounds),	4.00	Wheat bran (pounds),	4.00
Maize feed (pounds),	4.00	Maize feed (pounds),	4.00
Dent corn ensilage (pounds),	33.88	Sweet corn ensilage (pounds)	57.41
Nutritive ratio,	1:5.25	Nutritive ratio,	1:5.92
Total cost (cents),	13.64	Total cost (cents),	16.58
Manurial value obtainable (cents),	6.68	Manurial value obtainable (cents),	7.52
Net cost (cents),	6.96	Net cost (cents),	9.06

Average Composition, etc. — Concluded.

V.		VI.	
March 29 to April 9.		*April 26 to May 16.*	
Wheat bran (pounds),	4.00	Wheat bran (pounds),	4.00
Maize feed (pounds),	4.00	Gluten feed (pounds),	4.00
Corn stover (pounds),	11.23	Hay (pounds),	10.00
Nutritive ratio,	1:5.67	Sugar beets (pounds),	15.00
Total cost (cents),	12.21	Nutritive ratio,	1:5.83
Manurial value obtainable (cents),	7.06	Total cost (cents),	20.25
Net cost (cents),	5.15	Manurial value obtainable (cents),	8.24
		Net cost (cents),	12.01

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
Total cost,	18.53	19.28	13.64	16.58	12.21	20.25
Manurial value obtainable,	7.87	7.95	6.68	7.52	7.06	8.24
Net cost,*	10.66	11.33	6.96	9.06	5.15	12.01

* Allowing ninety-two per cent. of the manurial value of the feed consumed obtainable.

Gain required in Pounds, per Day, of Live Weight, to cover Expenses for Feed.

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
On total cost,	4.94	5.14	3.64	4.42	3.26	5.40
On net cost,	2.84	3.02	1.86	2.42	1.37	3.20

How far in the case of each steer these rates of daily increase in their live weight have been realized in case of each specified fodder ration may be seen from the subsequent detailed feeding record of each animal.

Conclusions.

The results of the third feeding experiment with young steers do not materially differ in their general aspect from those obtained in our two preceding experiments.

1. During the first winter season the daily gain in live weight during the sixth feeding period reached 3.2 pounds (steer No. 3), and it averaged for the entire lot of steers (three) at that time 2.69 pounds per head. This gain represents 0.34 pounds on every one hundred pounds of live weight of the animal on trial (800 pounds each).

2. During the second winter season the same lot of steers gained, during one feeding period (I. period), on an average, 2.5 pounds of live weight per day; in case of one steer it was as high as 3.05 pounds per day. This rate of daily increase in live weight is equal to 0.21 pounds on each hundred pounds of live weight, with a total weight of 1,100 pounds per head.

3. The total local market cost of the different stated daily fodder rations used during the first winter season varies from 10.7 to 18.36 cents, and their net cost from 4.46 to 9.10 cents, leaving manurial refuse equal in commercial value to one-half of the local retail market cost of the feed consumed.

4. The total local market cost of the daily fodder rations used during the second winter season varies from 12.2 to 20.28 cents, and their net cost from 5.1 to 12.01 cents, leaving a manurial refuse equal to two-fifths of the local retail market cost of the fodder articles which constitute the stated fodder rations.

5. The average daily gain in live weight, taking the entire experiment into consideration, is somewhat higher than that noticed in the second experiment; yet at no period of the trial does the daily increase in live weight at $3\frac{3}{4}$ cents market cost per pound of live weight equal the entire local market cost of the feed consumed in connection with its production. This result is due in some degree, no doubt, to the contemporary high local market cost of some of the fodder ingredients largely used in the making up of the daily fodder rations.

The results of our experiments in this connection are, as may be noticed from preceding reports, rather more instructive than remunerative. A market cost of $3\frac{1}{2}$ cents per pound of live weight in cases of yearlings, with $3\frac{3}{4}$ cents per pound of live weight in cases of matured steers, leaves, it will be conceded, but a small margin of cash profits. The largest daily increase in live weight, in case of any diet thus far experimented with, was 0.46 pounds per one hundred pounds of live weight, with yearlings weighing from 650 to 700 pounds per head; while in case of two-year-old steers, weighing from 1,100 to 1,150 pounds per head, it reached but 0.3 pounds for every one hundred pounds of their live weight. The highest daily increase in live weight during any feeding period in case of yearlings thus far secured by us amounted to 2.9 pounds per head, and in case of two-year-olds to 3.4 pounds per head. These results represent a market value of live weight gained at above-stated local meat market prices of 10.87 cents in case of yearlings, and 12.55 cents in case of two-year-old steers. Our results fall behind daily, thus far, about one pound of gain in live weight to cover the market cost of the feed consumed for its production; 14 to 15 cents in case of yearlings, 18 to 19 cents in case of two-year-old steers.

The necessity of efficient and cheap fodder rations being quite evident, it seems desirable to try, more generally, fodder crops of a higher nutritive character than the majority of our meadows and pastures furnishes at present.

Steer No. 1.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.										Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Hay.	Turnips.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Corn Stover.	Sugar Beets.					
1891-92.															
Nov. 10 to Dec. 22,	3.44	3.44	–	12.17	17.38	–	–	–	–	–	18.92	1:5.91	925	1,020	2.26
Dec. 29 to Jan. 13,	4.00	4.00	–	9.25	–	15.00	–	–	–	–	17.44	1:5.50	1,050	1,060	0.67
Jan. 19 to Feb. 23,	4.00	4.00	–	–	–	–	32.87	–	–	–	13.85	1:5.24	1,085	1,100	0.43
March 1 to March 23,	4.00	4.00	–	–	–	–	–	65.01	–	–	17.46	1:5.99	1,120	1,170	2.27
March 29 to April 9,	4.00	4.00	–	–	–	–	–	–	11.45	–	16.40	1:5.70	1,140	1,140	0.00
April 26 to May 16,	4.00	–	4.00	10.00	–	–	–	–	–	15.00	18.48	1:5.83	1,202	1,225	1.15

	Pounds.
Live weight of animal at the beginning of the experiment,	925.00
Live weight of animal at the time of killing,	1,225.00
Live weight gained during the experiment,	300.00
Average gain in weight per day (entire experiment),	1.60
Highest average gain in live weight per day, IV. period,	2.27
Lowest average gain in live weight per day, V. period,	0.00

Steer No. 2.

Feeding Periods.	Feed consumed (Pounds) per Day.										Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Hay.	Turnips.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Corn Stover.	Sugar Beets.					
1891-92.															
Nov. 10 to Dec. 22, .	3.44	3.44	–	9.81	17.38	–	–	–	–	–	16.79	1 : 5.70	926	1,018	2.19
Dec. 29 to Jan. 13, .	4.00	4.00	–	9.00	–	15.00	–	–	–	–	17.21	1 : 5.30	1,065	1,065	0.00
Jan. 19 to Feb. 23, .	4.00	4.00	–	–	–	–	33.74	–	–	–	14.03	1 : 5.25	1,080	1,100	0.57
March 1 to March 23, .	4.00	4.00	–	–	–	–	–	47.45	–	–	14.70	1 : 5.62	1,115	1,145	1.36
March 29 to April 9, .	4.00	4.00	–	–	–	–	–	–	10.64	–	15.75	1 : 5.52	1,115	1,122	0.64
April 26 to May 16, .	4.00	–	4.00	10.00	–	–	–	–	–	15.00	18.48	1 : 5.83	1,160	1,178	0.90

	Pounds.
Live weight of animal at the beginning of the experiment,	926.00
Live weight of animal at the time of killing,	1,178.00
Live weight gained during the experiment,	252.00
Average gain in weight per day (entire experiment),	1.34
Highest average gain in live weight per day, I. period,	2.19
Lowest average gain in live weight per day, II. period,	0.00

Steer No. 3.

Feeding Periods.	Feed consumed (Pounds) per Day.										Total Amount of Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Hay.	Turnips.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Corn Stover.	Sugar Beets.					
1891-92.															
Nov. 10 to Dec. 22, .	3.44	3.44	–	11.10	17.38	–	–	–	–	–	17.96	1 : 5.83	955	1,040	2.02
Dec. 29 to Jan. 13, .	4.00	4.00	–	9.26	–	15.00	–	–	–	–	17.45	1 : 5.50	1,082	1,085	0.20
Jan. 19 to Feb. 23, .	4.00	4.00	–	–	–	–	35.03	–	–	–	14.28	1 : 5.26	1,090	1,125	1.00
March 1 to March 23, .	4.00	4.00	–	–	–	–	–	59.77	–	–	16.63	1 : 5.95	1,133	1,200	3.05
March 29 to April 9, .	4.00	4.00	–	–	–	–	–	–	11.60	–	16.52	1 : 5.73	1,160	1,165	0.45
April 26 to May 16, .	4.00	–	4.00	10.00	–	–	–	–	–	15.00	18.48	1 : 5.83	1,210	1,230	1.00

	Pounds.
Live weight of animal at the beginning of the experiment,	955.00
Live weight of animal at the time of killing,	1,230.00
Live weight gained during the experiment,	275.00
Average gain in weight per day (entire experiment),	1.46
Highest average gain in live weight per day, IV. period,	3.05
Lowest average gain in live weight per day, II. period,	0.20

III.

WINTER FEEDING EXPERIMENTS WITH LAMBS.

November, 1891, to May, 1892.

The experiment briefly described in a few succeeding pages is the third one of a series designed for the purpose of studying the feeding effect and general economy of different combinations of grain feed stuffs when fed in connection with the same or similar kinds of coarse fodder articles for the production of meat.

During our *first* experiment, corn meal, wheat bran and gluten meal (Chicago) furnished in varying proportions the grain feed part of the daily diet (see eighth annual report, pages 67–90). During the *second*, corn meal, wheat bran, old-process linseed meal and gluten meal (Chicago) served for that purpose (see ninth annual report, pages 128–147); while in the *third experiment*, which is here under discussion, *wheat bran*, *Buffalo gluten feed* and *Chicago maize feed* have been used as the grain feed part of the daily feed.

The coarse feed portion of the daily diet during the first and second experiments consisted exclusively of rowen (hay of the second cut of upland meadows) and of corn ensilage. In the third experiment during one feeding period corn ensilage was substituted by roots (globe mangolds). The selection of lambs in all these trials was confined to our local supply. From six to nine animals served in each case for our observations.

Six lambs, wethers, grades of uncertain parentage, were selected for the experiment here under consideration. Each animal occupied a separate pen during the entire time of observation; none of them were shorn before entering upon the trial.

1. *Live Weight and Cost of Lambs.*

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Total.
Live weight (pounds), ...	74.00	68.50	67.25	73.50	65.00	77.75	426.00
Market cost at 5.5 cents per pound, .	$4 07	$3 77	$3 70	$4 04	$3 58	$4 28	$23 44

2. *Character and Cost of Fodder Articles.*

The grain feed used consisted of wheat bran, Chicago maize feed and Buffalo gluten feed bought in our local market. These articles were of a fair quality and of a good mechanical condition. *Chicago maize feed* and *Buffalo gluten feed* are waste products obtained from maize in connection with the manufacture of glucose-sugar; they are valuable recent additions to our commercial resources of concentrated feed stuffs. The coarse feed stuffs, consisting of rowen (hay of second cut of upland meadows), of corn ensilage and of globe mangolds, were produced at the station, and were of the same good quality as those described in a previous bulletin (No. 42). The local market value and the chemical composition of the various fodder articles used at different times in the daily diet are recorded in the subsequent tabular statements.

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran, ...	$22 00
Maize feed (Chicago), ...	25 00
Gluten feed (Buffalo), ...	23 00
Rowen, ...	15 00
Globe mangolds, ...	4 00
Dent corn ensilage, ...	2 50
Sweet corn ensilage, ...	2 50

Analyses of the Various Articles of Fodder used.

Food Analyses.	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.
Moisture at 100° C.,	10.01	8.70	8.97	13.90	87.75	79.92	84.30
Dry matter,	89.99	91.30	91.03	86.10	12.25	20.08	15.70
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.58	0.78	0.77	8.28	9.06	4.99	6.32
" cellulose,	11.77	7.97	5.09	28.88	7.94	27.19	29.32
" fat,	5.04	7.37	13.46	3.91	0.88	3.29	7.36
" protein,	18.06	27.55	26.16	13.45	10.37	8.29	7.86
Non-nitrogenous extract matter,	58.55	56.33	54.52	45.48	71.75	56.24	49.14
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.
Moisture,	10.01	8.70	8.97	13.90	87.75	79.92	84.30
Nitrogen,	2.60	4.03	3.81	1.853	0.203	0.27	0.20
Phosphoric acid,	2.85	0.70	0.69	0.464	0.093	0.14	0.089
Potassium oxide,	1.63	0.43	0.42	1.966	0.383	0.33	0.41
Valuation per 2,000 pounds,	$12 40	$13 25	$12 57	$7 84	$1 06	$1 26	$1 06

3. *Mode of Feeding.*

The grain feed portion of the daily diet consisted in every instance of *equal weights* of either wheat bran and Chicago maize feed or of wheat bran and Buffalo gluten feed. The amount of each used per head in the daily fodder ration varied in different feeding periods somewhat; during the earlier stages of the experiment it amounted to five ounces of each, per head, during later periods to six ounces. All animals received the same quantity at the same stage of the observation.

The daily coarse feed rations consisted either of rowen hay or of rowen hay with either corn ensilage or roots (globe mangolds). Whenever corn ensilage or roots were fed in common with rowen hay, only one-half of the customary daily rowen ration was given, while the consumption of corn ensilage or of the roots was governed by the appetite of each animal. One-half of the daily fodder ration — fine and coarser feed — was fed in the morning and the other half later in the afternoon. Water was given once a day, a few hours after feeding (mornings).

The entire experiment extended over a period of one hundred and eighty-three days, and was subdivided into five distinct feeding periods, varying in length from fourteen to thirty-five days, with five days between the periods.

Average Composition of the Daily Fodder Rations used during the Six Successive Feeding Periods.

I.		II.	
November 17 to December 1.		*December 5 to January 13.*	
Wheat bran (pounds),	0.34	Wheat bran (pounds),	0.33
Maize feed (pounds),	0.34	Maize feed (pounds),	0.33
Rowen (pounds),	1.37	Rowen (pounds),	0.68
Nutritive ratio,	1 : 4.84	Globe mangolds (pounds),	2.97
Total cost (cents),	1.83	Nutritive ratio,	1 : 5.12
Manurial value obtainable (cents),	0.89	Total cost (cents),	1.88
Net cost (cents),	0.94	Manurial value obtainable (cents),	0.78
		Net cost (cents),	1.10

III.		IV.	
January 17 to February 22.		*February 26 to March 23.*	
Wheat bran (pounds),	0.35	Wheat bran (pounds),	0.38
Maize feed (pounds),	0.35	Maize feed (pounds),	0.38
Rowen (pounds),	0.77	Rowen (pounds),	0.84
Dent corn ensilage (pounds),	1.97	Sweet corn ensilage (pounds),	2.68
Nutritive ratio,	1 : 5.26	Nutritive ratio,	1 : 5.34
Total cost (cents),	1.65	Total cost (cents),	1.86
Manurial value obtainable (cents),	0.80	Manurial value obtainable (cents),	0.88
Net cost (cents),	0.85	Net cost (cents),	0.98

Average Composition, etc. — Concluded.

V.		VI.	
March 27 to April 23.		*April 27 to May 18.*	
Wheat bran (pounds),	0.40	Wheat bran (pounds),	0.40
Maize feed (pounds),	0.40	Gluten feed (pounds),	0.40
Rowen (pounds),	1.40	Rowen (pounds),	1.37
Nutritive ratio,	1:4.79	Nutritive ratio,	1:5.02
Total cost (cents),	1.99	Total cost (cents),	1.93
Manurial value obtainable (cents),	0.98	Manurial value obtainable (cents),	0.95
Net cost (cents),	1.01	Net cost (cents),	0.98

Summary of Cost of the Above-stated Average Daily Fodder Rations used.

[Cents.]

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
Total cost,	1.83	1.88	1.65	1.86	1.99	1.93
Manurial value obtainable,	0.89	0.78	0.80	0.88	0.98	0.95
Net cost,*	0.94	1.10	0.85	0.98	1.01	0.98

* Allowing ninety-two per cent. of the manurial value of the feed consumed obtainable.

4. *Gain in Live Weight during Experiment.*

[Pounds.]

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Average.
Live weight at beginning of experiment,	74.00	68.50	67.25	73.50	65.00	77.75	71.00
Live weight at close of experiment,	97.00	85.50	87.50	85.00	75.00	98.50	88.08
Live weight gained during experiment,	23.00	17.00	20.25	11.50	10.00	20.75	17.07

The live weight of the lambs (six) engaged in our first experiment averaged, at the beginning of our experiments, 71 pounds; of those engaged in the second experiment (six) it averaged 53.5 pounds.

Yield of Dressed Weight.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Total.
Pounds of dressed weight,	52.25	46.50	44.00	43.00	36.00	53.25	275.00
Returns at 11 cents per pound,	$5 75	$5 11	$4 84	$4 73	$3 96	$5 86	$30 25

Yield of Wool.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Total.
Pounds of wool,	6.50	5.25	5.75	5.25	6.25	5.75	34.75
Returns at 21 cents per pound,	$1 37	$1 10	$1 21	$1 10	$1 31	$1 21	$7 30

5. *Financial Results.*

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Total.
Cost of lambs,	$4 11	$3 82	$3 75	$4 18	$3 73	$4 35	
Cost of feed consumed,	3 67	3 38	3 41	3 53	2 75	3 54	
	$7 78	$7 20	$7 16	$7 71	$6 48	$7 89	$44 22
Value received for meat,	$5 75	$5 11	$4 84	$4 73	$3 96	$5 86	
Value received for wool,	1 37	1 10	1 21	1 10	1 31	1 21	
Value of obtainable manure,	1 73	1 59	1 60	1 67	1 28	1 66	
	$8 85	$7 70	$7 65	$7 50	$6 55	$8 73	$47 08

Conclusions.

1. The average daily increase in live weight as compared with that noticed in the two preceding experiments is not as satisfactory; lambs 4 and 5 fall not less than fifty per cent. behind, when compared with the gain obtained in case of lambs 1, 3 and 6.

2. The feeding effect of corn ensilage, when fed with the same kind and amount of grain feed, compares well with that of globe mangold roots.

3. The market cost of the daily fodder rations above stated is in the majority of cases lower than that of those used in our preceding experiments with lambs; it varies from 1.65 cents to 1.93 cents in different feeding periods.

4. The manurial value obtainable from the different daily fodder rations varies from 0.78 to 0.98 cents; it amounts to one-half of the market cost of the daily diet.

5. The temporary ruling low market cost of the grain feed during the third experiment, as compared with those on preceding occasions, and the high commercial value of the obtainable manurial refuse, due to their rich nitrogenous composition, have secured still a small profit over expenses charged where the rate of producing meat was too low to entitle to profit. In considering the stated financial results in all our feeding experiments, thus far published, it ought to be kept in mind that all our home-raised fodder articles are charged at a liberal local market price per ton.

Sheep No. 1.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.					
1891-92.												
Nov. 17 to Dec. 1,	0.34	0.34	–	1.35	–	–	–	1.78	0.07	25.43	1:4.84	74.58
Dec. 5 to Jan. 13,	0.33	0.33	–	0.68	3.00	–	–	1.55	0.28	5.54	1:5.12	78.87
Jan. 17 to Feb. 22,	0.37	0.37	–	0.86	–	1.94	–	1.80	0.18	10.00	1:5.26	89.92
Feb. 26 to March 23,	0.48	0.48	–	1.00	–	–	3.42	2.27	0.21	10.81	1:5.34	96.20
March 27 to April 23,	0.50	0.50	–	1.35	–	–	–	2.07	0.13	15.92	1:4.78	98.38
April 27 to May 18,	0.50	–	0.50	1.31	–	–	–	2.03	-0.29	–	1:5.00	100.37

Total Amount of Feed consumed from Nov. 17, 1891, to May 18, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
75.25 pounds wheat bran, . . .	67.62	$0 83	$0 47
63.25 pounds maize feed, . . .	57.75	0 79	0 42
12.00 pounds gluten feed, . . .	10.92	0 14	0 08
189.50 pounds rowen, ...	163.15	1 42	0 74
128.00 pounds globe mangolds, . .	15.68	0 26	0 07
82.00 pounds dent corn ensilage, . .	16.47	0 10	0 05
101.00 pounds sweet corn ensilage,. .	15.87	0 13	0 05
	347.46	$3 67	$1 88

	Pounds.
Live weight of animal at the beginning of the experiment, .	74.00
Live weight of animal at the time of killing, ...	97.00
Live weight gained during the experiment, ...	23.00
Average gain in weight per day (entire experiment), . .	0.126
Dressed weight of animal, ...	52.25
Loss in weight by dressing, 46.13 per cent., or	44.75

Pounds of dry matter fed produced 1 pound of live weight, 15.11.

Cost of feed per pound of live weight gained, 15.96 cents.

Net cost of feed per pound gained after deducting 8 per cent. of manurial value, 8.43 cents.

Sheep No. 2.

FEEDING PERIODS.	Feed consumed (Pounds) per Day. Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Total Amount of Dry Matter consumed per Day (Pounds).	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
1891-92.												
Nov. 17 to Dec. 1,	0.34	0.34	–	1.35	–	–	–	1.78	0.21	8.48	1 : 4.84	70.33
Dec. 5 to Jan. 13,	0.33	0.33	–	0.63	2.79	–	–	1.48	0.18	8.22	1 : 5.10	73.17
Jan. 17 to Feb. 22,	0.37	0.37	–	0.89	–	1.85	–	1.81	0.14	12.95	1 : 5.26	82.67
Feb. 26 to March 23,	0.37	0.37	–	0.85	–	–	2.00	1.71	0.13	13.15	1 : 5.33	85.56
March 27 to April 23,	0.37	0.37	–	1.46	–	–	–	1.93	0.13	14.85	1 : 4.79	88.50
April 27 to May 18,	0.37	–	0.37	1.45	–	–	–	1.92	–0.25	–	1 : 5.04	89.31

Total Amount of Feed consumed from Nov. 17, 1891, to May 18, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
65.62 pounds wheat bran, . . .	59.05	$0 72	$0 41
56.62 pounds maize feed, . . .	51.69	0 71	0 37
9.00 pounds gluten feed, . . .	8.19	0 10	0 06
190.50 pounds rowen, ...	164.02	1 43	0 75
120.00 pounds globe mangolds, . .	14.70	0 24	0 06
78.50 pounds dent corn ensilage, . .	15.76	0 10	0 05
65.00 pounds sweet corn ensilage, . .	10.21	0 08	0 03
	323.62	$3 38	$1 73

	Pounds.
Live weight of animal at the beginning of the experiment, .	68.50
Live weight of animal at the time of killing, ...	85.50
Live weight gained during the experiment, ...	17.00
Average gain in weight per day (entire experiment), . .	0.093
Dressed weight of animal, ...	46.50
Loss in weight by dressing, 45.61 per cent., or	39.00

Pounds of dry matter fed produced 1 pound of live weight, 19.04.

Cost of feed per pound of live weight gained, 19.88 cents.

Net cost of feed per pound gained after deducting 8 per cent. of manurial value, 10.53 cents.

Sheep No. 3.

Feeding Periods.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.					
1891-92.												
Nov. 17 to Dec. 1,	0.31	0.31	–	1.25	–	–	–	1.64	0.23	7.13	1 : 4.84	69.25
Dec. 5 to Jan. 13,	0.37	0.37	–	0.83	3.00	–	–	1.75	0.22	7.95	1 : 5.12	74.42
Jan. 17 to Feb. 22,	0.37	0.37	–	0.81	–	1.51	–	1.67	0.10	16.70	1 : 5.25	80.90
Feb. 26 to March 23,	0.37	0.37	–	0.94	–	–	1.96	1.79	0.08	22.38	1 : 5.33	84.12
March 27 to April 23,	0.37	0.37	–	1.39	–	–	–	1.87	0.03	62.33	1 : 4.78	86.87
April 27 to May 18,	0.37	–	0.37	1.21	–	–	–	1.71	0.13	13.15	1 : 5.02	87.81

Total Amount of Feed consumed from Nov. 17, 1891, to May 18, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
67.00 pounds wheat bran, ...	60.29	$0 74	$0 42
58.00 pounds maize feed, ...	52.95	0 73	0 38
9.00 pounds gluten feed, ...	8.19	0 10	0 06
189.50 pounds rowen, ...	163.15	1 42	0 74
128.00 pounds globe mangolds, . .	15.68	0 26	0 07
66.50 pounds dent corn ensilage, . .	13.35	0 08	0 04
63.00 pounds sweet corn ensilage, . .	9.89	0 08	0 03
	323.50	$3 41	$1 74

	Pounds.
Live weight of animal at the beginning of the experiment, .	67.25
Live weight of animal at the time of killing, ...	87.50
Live weight gained during the experiment, ...	20.25
Average gain in weight per day (entire experiment), . . .	0.110
Dressed weight of animal, ...	44.00
Loss in weight by dressing, 49.71 per cent., or	43.50

Pounds of dry matter fed produced 1 pound of live weight, 15.97.

Cost of feed per pound of live weight gained, 16.84 cents.

Net cost of feed per pound gained after deducting 8 per cent. of manurial value, 8.93.

Sheep No. 4.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.					
1891-92.												
Nov. 17 to Dec. 1,	0.33	0.33	-	1.32	-	-	-	1.73	0.11	15.73	1 : 4.84	74.08
Dec. 5 to Jan. 13,	0.37	0.37	-	0.80	3.00	-	-	1.72	0.18	9.56	1 : 5.12	79.33
Jan. 17 to Feb. 22,	0.37	0.37	-	1.00	-	2.00	-	1.93	0.05	38.60	1 : 5.26	84.70
Feb. 26 to March 23,	0.37	0.37	-	1.00	-	-	2.61	1.94	0.13	14.92	1 : 5.36	86.75
March 27 to April 23,	0.37	0.37	-	1.39	-	-	-	1.87	0.06	31.17	1 : 4.78	89.87
April 27 to May 18,	0.37	-	0.37	1.43	-	-	-	1.90	−0.22	-	1 : 5.04	89.19

Total Amount of Feed consumed from Nov. 17, 1891, to May 18, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
67.50 pounds wheat bran,	60.74	$0 74	$0 42
58.50 pounds maize feed,	53.41	0 73	0 39
9.00 pounds gluten feed,	8.19	0 10	0 06
198.50 pounds rowen,	160.91	1 49	0 78
128.00 pounds globe mangolds,	15.68	0 26	0 07
84.00 pounds dent corn ensilage,	16.87	0 11	0 05
80.00 pounds sweet corn ensilage,	12.56	0 10	0 04
	328.36	$3 53	$1 81

	Pounds.
Live weight of animal at the beginning of the experiment,	73.50
Live weight of animal at the time of killing,	85.00
Live weight gained during the experiment,	11.50
Average gain in weight per day (entire experiment),	0.063
Dressed weight of animal,	43.00
Loss in weight by dressing, 49.41 per cent., or	42.00

Pounds of dry matter fed produced 1 pound of live weight, 28.55.

Cost of feed per pound of live weight gained, 30.70 cents.

Net cost of feed per pound gained after deducting 8 per cent. of manurial value, 16.17 cents.

Sheep No. 5.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.					
1891-92.												
Nov. 17 to Dec. 1, . . .	0.31	0.31	–	1.23	–	–	–	1.62	0.02	81.00	1 : 4.84	64.67
Dec. 5 to Jan. 13, . . .	0.27	0.27	–	0.33	3.00	–	–	1.14	0.15	7.60	1 : 5.12	68.79
Jan. 17 to Feb. 22, . . .	0.25	0.25	–	0.39	–	2.00	–	1.19	0.06	19.83	1 : 5.24	73.95
Feb. 26 to March 23, . . .	0.26	0.26	–	0.56	–	–	2.42	1.33	0.04	33.25	1 : 5.30	76.37
March 27 to April 23, . . .	0.31	0.31	–	1.44	–	–	–	1.80	-0.20	–	1 : 4.85	76.62
April 27 to May 18, . . .	0.31	–	0.31	1.48	–	–	–	1.84	0.39	4.72	1 : 5.10	74.17

Total Amount of Feed consumed from Nov. 17, 1891, to May 18, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
51.50 pounds wheat bran,	46.34	$0 57	$0 32
44.00 pounds maize feed,	40.17	0 55	0 29
7.50 pounds gluten feed,	6.83	0 09	0 05
144.25 pounds rowen,	124.20	1 08	0 57
128.00 pounds globe mangolds,	15.68	0 26	0 07
84.50 pounds dent corn ensilage,	16.97	0 11	0 05
75.00 pounds sweet corn ensilage,	11.78	0 09	0 04
	261.97	$2 75	$1 39

	Pounds.
Live weight of animal at the beginning of the experiment,	65.00
Live weight of animal at the time of killing,	75.00
Live weight gained during the experiment,	10.00
Average gain in weight per day (entire experiment),	0.054
Dressed weight of animal,	36.00
Loss in weight by dressing, 52.00 per cent., or	39.00

Pounds of dry matter fed produced 1 pound of live weight, 26.20.

Cost of feed per pound of live weight gained, 27.50 cents.

Net cost of feed per pound gained after deducting 8 per cent. of manurial value, 14.70 cents.

Sheep No. 6.

Feeding Periods.	Feed consumed (Pounds) per Day.							Total Amount of Dry Matter consumed per Day (Pounds).	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Maize Feed.	Gluten Feed.	Rowen.	Globe Mangolds.	Dent Corn Ensilage.	Sweet Corn Ensilage.					
1891-92.												
Nov. 17 to Dec. 1,	0.42	0.42	–	1.70	–	–	–	2.22	0.16	13.88	1 : 4.84	79.33
Dec. 5 to Jan. 13,	0.32	0.32	–	0.79	3.00	–	–	1.63	0.16	10.19	1 : 5.14	83.12
Jan. 17 to Feb. 22,	0.35	0.35	–	0.64	–	2.51	–	1.69	0.10	16.90	1 : 5.27	91.35
Feb. 26 to March 23,	0.40	0.40	–	0.69	–	–	3.69	1.90	0.17	11.18	1 : 5.38	97.19
March 27 to April 23,	0.50	0.50	–	1.39	–	–	–	2.10	0.23	9.13	1 : 4.78	101.62
April 27 to May 18,	0.50	–	0.50	1.36	–	–	–	2.07	–0.34	–	1 : 5.00	103.50

Total Amount of Feed consumed from Nov. 17, 1891, to May 18, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
73.12 pounds wheat bran, . . .	65.79	$0 80	$0 45
61.12 pounds maize feed, . . .	55.80	0 76	0 40
12.00 pounds gluten feed, . . .	10.92	0 14	0 08
174.50 pounds rowen, ...	150.24	1 31	0 68
128.00 pounds globe mangolds, . .	15.68	0 26	0 07
102.50 pounds dent corn ensilage, . .	20.58	0 13	0 06
108.00 pounds sweet corn ensilage, . .	16.96	0 14	0 06
	335.97	$3 54	$1 80

	Pounds.
Live weight of animal at the beginning of the experiment, .	77.75
Live weight of animal at the time of killing, ...	98.50
Live weight gained during the experiment, ...	20.75
Average gain in weight per day (entire experiment), . .	0.113
Dressed weight of animal, ...	53.25
Loss in weight by dressing, 45.94 per cent., or	45.25

Pounds of dry matter fed produced 1 pound live weight, 16.19.

Cost of feed per pound of live weight gained, 17.06 cents.

Net cost of feed per pound gained after deducting 8 per cent. of manurial value, 9.06 cents.

IV.

FEEDING EXPERIMENTS WITH PIGS (TWO).

1891–92.

Introduction. — The results of fifteen different feeding experiments with young pigs, grades and thoroughbreds, for the meat market, have already been published in our preceding annual reports. The results of two new experiments are reported on the present occasion.

We usually keep, the whole year around, one young pig for every cow in the dairy, to dispose of our skim-milk. On the average, five lots of young pigs are prepared for the meat market every two years. The animals are usually bought when from five to six weeks old, and weigh from 25 to 30 pounds per head. They are fed until they reach a live weight of from 180 to 190 pounds, when they are sold to the butcher.

From 112 to 125 days are usually required to produce the desired live weight. Their daily gain in live weight has been from 1.4 to 1.5 pounds. During spring, summer and autumn one to two weeks less time is needed than during the winter season to finish the operation. The shrinkage from live weight to dressed weight varies usually from 18 to 21 per cent.

Our daily supply of skim-milk rarely exceeds five quarts per head of young pigs. We usually begin feeding from two to three ounces of corn meal with every quart of skim-milk required at the time. As soon as the live weight has reached from 60 to 70 pounds per head we increase the corn meal to four ounces per quart of skim-milk consumed.

The additional feed subsequently called for has usually been made of either a suitable mixture of several kinds of commercial feed stuffs, as wheat bran and Chicago gluten meal, or dried brewers' grain and gluten meal, or ground

barley and Chicago maize feed; or some single feed stuff, as Buffalo gluten feed or Chicago maize feed. The market cost of the various feed stuffs suitable for the purpose largely controls, for obvious reasons, their temporary selection.

During the present year (1892) Chicago maize feed and Buffalo gluten feed have been chosen for our observation. The market cost of the feed consumed per pound of dressed pork produced has varied during past years from 4.3 to 6.4 cents.

The available manurial refuse has amounted to two-fifths of the market cost of the feed consumed. Dressed pork has of late sold at from 6½ to 7½ cents per pound. Allowing 20 per cent. of shrinkage —

7.25 cents per pound of dressed weight is equal to 5.8 cents per pound live weight.
6.50 cents per pound of dressed weight is equal to 5.2 cents per pound live weight.
6.00 cents per pound of dressed weight is equal to 4.8 cents per pound live weight.

Sixteenth Feeding Experiment with Pigs.

September, 1891, to February, 1892.

Six pigs, grade Chester Whites, were purchased on Sept. 12, 1891, at $2.50 apiece. Three were sows and three barrows. For a period of about nine weeks preceding the experiment proper the pigs were fed on skim-milk and potatoes. The potatoes were boiled and mashed with the milk. The figures below are for the entire six pigs, no individual records having been kept of this period.

Total Amount of Feed consumed from Sept. 22, 1891, to Nov. 28, 1891.

	Cost.	Manurial Value.
1,875.00 quarts skim-milk, ...	$8 44	$3 97
1,752.00 pounds potatoes, ...	5 25*	0 84
	$13 69	$4 81

* At 15 cents per bushel, small, and not suitable for family use.

	Pounds.
Total live weight of the six pigs September 22,	244.00
Total live weight of the six pigs November 28,	520.50
Total live weight gained,	276.50
Average gain in weight per day (entire period),	4.13
Average daily gain per pig,	0.69

Total cost of feed per pound of live weight gained, 4.95 cents.

Net cost of feed per pound gained after deducting 30 per cent. of manurial value, 3.73 cents.

Local Market Cost of the Various Articles of Fodder used.

Barley meal, per ton,	$30 00
Skim-milk, per gallon,	0 018
Wheat bran, per ton,	22 00
Maize feed (Chicago), per ton,	25 00

Analyses of the Various Articles of Fodder used.

Food Analyses.	Barley Meal.	Skim-milk.	Wheat Bran.	Maize Feed.
Moisture at 100° C.,	12.90	89.78	10.01	8.70
Dry matter,	87.10	10.22	89.99	91.30
	100.00	100.00	100.00	100.00
Analysis of Dry Matter.				
Crude ash,	2.30	6.85	6.58	0.78
" cellulose,	7.11	–	11.77	7.97
" fat,	1.94	3.82	5.04	7.37
" protein,	10.80	31.60	18.06	27.55
Non-nitrogenous extract matter,	77.85	57.73	58.55	56.33
	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Barley Meal.	Skim-milk.*	Wheat Bran.	Maize Feed.
Moisture,	12.90	89.78	10.01	8.70
Nitrogen,	1.507	0.52	2.60	4.03
Phosphoric acid,	0.664	0.19	2.85	0.70
Potassium oxide,	0.342	0.20	1.63	0.43
Valuation per 2,000 pounds,	$5 56	$1 95	$12 40	$13 25

* One quart equals 2.17 pounds.

Conclusions.

1. The entire lot of young pigs (six), weighing on an average 40 pounds per head, gained in 69 days, when fed in one pen together on boiled potatoes and skim-milk (one pound of potatoes to every quart of milk consumed), 46 pounds in live weight per head, or 0.69 pounds per day, at an average cost of 4.95 cents per pound of live weight gained.

2. The same lot of pigs, when subsequently isolated in six different pens and fed on a daily diet consisting, as previously specified, of skim-milk, barley meal, wheat bran and Chicago maize feed, gained on an average in 65 days 95.5 pounds each, or 1.49 pounds per day, at an average total cost of 5.64 cents per pound of live weight, or 4.8 cents of net cost.

3. The high cost of feed per pound of live weight gained in this experiment is due to two causes, namely, low rate of daily increase in live weight during the first half of the time occupied by the experiment, and to the high market cost of the ground barley used in large quantities during the second half of the experiment.

Pig No. 1.

Feeding Period.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1891-92. Dec. 1 to Feb. 3,	169.37	344.00	77.06	77.06	1:4.07	71.00	171.00	1.56

Total Amount of Feed consumed from Dec. 1, 1891, to Feb. 3, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
169.37 pounds barley meal,	147.52	$2 54	$0 47
344.00 quarts skim-milk,	76.29	1 55	0 73
77.06 pounds wheat bran,	69.35	0 85	0 48
77.06 pounds maize feed,	70.36	0 96	0 51
	363.52	$5 90	$2 19

	Pounds.
Live weight of animal at the beginning of the experiment,	71.00
Live weight of animal at the time of killing,	171.00
Live weight gained during the experiment,	100.00
Dressed weight of animal,	131.50
Loss in weight by dressing, 23.10 per cent., or	39.50
Dressed weight gained during the experiment,	76.90

Pounds of dry matter fed produced 1 pound of live weight, 3.64.

Pounds of dry matter fed produced 1 pound of dressed weight, 4.73.

Cost of feed per pound of dressed weight gained, 7.67 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of the manurial value, 5.69 cents.

Pig No. 2.

Feeding Period.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1891-92. Dec. 1 to Feb. 3,	172.00	344.00	94.03	94.03	1:4.03	94.00	194.00	1.56

Total Amount of Feed consumed from Dec. 1, 1891, to Feb. 3, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
172.00 pounds barley meal,	149.81	$2 58	$0 48
344.00 quarts skim-milk,	76.29	1 55	0 73
94.03 pounds wheat bran,	84.62	1 03	0 58
94.03 pounds maize feed,	85.85	1 18	0 62
	396.57	$6 34	$2 41

	Pounds.
Live weight of animal at the beginning of the experiment,	94.00
Live weight of animal at the time of killing,	194.00
Live weight gained during the experiment,	100.00
Dressed weight of animal,	149.00
Loss in weight by dressing, 23.20 per cent., or	45.00
Dressed weight gained during the experiment,	76.80

Pounds of dry matter fed produced 1 pound of live weight, 3.97.

Pounds of dry matter fed produced 1 pound of dressed weight, 5.16.

Cost of feed per pound of dressed weight gained, 8.25 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of the manurial value, 6.05 cents.

Pig No. 3.

Feeding Period.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1891-92. Dec. 1 to Feb. 3,	172.00	344.00	90.66	90.66	1 : 4.06	99.50	192.50	1.45

Total Amount of Feed consumed from Dec. 1, 1891, to Feb. 3, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
172.00 pounds barley meal,	149.81	$2 58	$0 48
344.00 quarts skim-milk,	76.29	1 55	0 73
90.66 pounds wheat bran,	81.58	1 00	0 56
90.66 pounds maize feed,	82.77	1 13	0 60
	390.45	$6 26	$2 37

	Pounds.
Live weight of animal at the beginning of the experiment,	99.50
Live weight of animal at the time of killing,	192.50
Live weight gained during the experiment,	93.00
Dressed weight of animal,	146.50
Loss in weight by dressing, 23.90 per cent., or	46.00
Dressed weight gained during the experiment,	70.77

Pounds of dry matter fed produced 1 pound of live weight, 4.20.

Pounds of dry matter fed produced 1 pound of dressed weight, 5.52.

Cost of feed per pound of dressed weight gained, 8.84 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of the manurial value, 6.50 cents.

Pig No. 4.

Feeding Period.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1891-92. Dec. 1 to Feb. 3, . .	172.00	344.00	80.34	80.34	1:4.08	92.75	185.00	1.44

Total Amount of Feed consumed from Dec. 1, 1891, to Feb. 3, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
172.00 pounds barley meal, . .	149.81	$2 58	$0 48
344.00 quarts skim-milk, . . .	76.29	1 55	0 73
80.34 pounds wheat bran, . .	72.30	0 88	0 50
80.34 pounds maize feed, . .	73.35	1 00	0 53
.	371.75	$6 01	$2 24

	Pounds.
Live weight of animal at the beginning of the experiment, .	92.75
Live weight of animal at the time of killing, ...	185.00
Live weight gained during the experiment, ...	92.25
Dressed weight of animal, ...	151.00
Loss in weight by dressing, 18.38 per cent., or	34.00
Dressed weight gained during the experiment, ...	75.29

Pounds of dry matter fed produced 1 pound of live weight, 4.03.

Pounds of dry matter fed produced 1 pound of dressed weight, 4.94.

Cost of feed per pound of dressed weight gained, 7.98 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of the manurial value, 5.90 cents.

Pig No. 5.

Feeding Period.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1891-92. Dec. 1 to Feb. 3,	172.00	344.00	90.47	90.47	1:4.06	92.50	192.00	1.55

Total Amount of Feed consumed from Dec. 1, 1891, to Feb. 3, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
172.00 pounds barley meal,	149.81	$2 58	$0 48
344.00 quarts skim-milk,	76.29	1 55	0 73
90.47 pounds wheat bran,	81.41	1 00	0 56
90.47 pounds maize feed,	82.60	1 13	0 60
	390.11	$6 26	$2 37

	Pounds.
Live weight of animal at the beginning of the experiment,	92.50
Live weight of animal at the time of killing,	192.00
Live weight gained during the experiment,	99.50
Dressed weight of animal,	142.00
Loss in weight by dressing, 26.04 per cent., or	50.00
Dressed weight gained during the experiment,	73.59

Pounds of dry matter fed produced 1 pound of live weight, 3.92.

Pounds of dry matter fed produced 1 pound of dressed weight, 5.30.

Cost of feed per pound of dressed weight gained, 8.51 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of the manurial value, 6.25 cents.

Pig No. 6.

Feeding Period.	Total Amount of Barley Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Wheat Bran consumed (Pounds).	Total Amount of Maize Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1891-92. Dec. 1 to Feb. 3,	172.00	344.00	82.59	82.59	1:4.08	91.50	180.00	1.38

Total Amount of Feed consumed from Dec. 1, 1891, to Feb. 3, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
172.00 pounds barley meal,	149.80	$2 58	$0 48
344.00 quarts skim-milk,	76.29	1 55	0 73
82.59 pounds wheat bran,	74.32	0 91	0 51
82.59 pounds maize feed,	75.40	1 03	0 55
	375.81	$6 07	$2 27

	Pounds.
Live weight of animal at the beginning of the experiment,	91.50
Live weight of animal at the time of killing,	180.00
Live weight gained during the experiment,	88.50
Dressed weight of animal,	147.00
Loss in weight by dressing, 18.33 per cent., or	33.00
Dressed weight gained during the experiment,	72.28

Pounds of dry matter fed produced 1 pound of live weight, 4.25.

Pounds of dry matter fed produced 1 pound of dressed weight, 5.20.

Cost of feed per pound of dressed weight gained, 8.40 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of the manurial value, 6.20 cents.

Seventeenth Feeding Experiment with Pigs.

March, 1892, to July, 1892.

Six pigs, grade Chester Whites, were purchased on Feb. 23, 1892, at $3.00 a piece. No. 2 and No. 3 were barrows and the rest were sows.

Local Market Cost of the Various Articles of Fodder used.

Corn meal, per ton,	$24 00
Skim-milk, per gallon,	0 018
Gluten feed (Buffalo), per ton,	23 00

The mode of feeding, as well as the general management of the experiment, has been the same as on previous occasions of a corresponding character.

Analyses of the Various Articles of Fodder used.

Food Analyses.	Corn Meal.	Skim-milk.	Gluten Feed.
Moisture at 100° C.,	13.96	89.78	8.97
Dry matter,	86.04	10.22	91.03
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	1.26	6.85	0.77
" cellulose,	1.49	–	5.09
" fat,	3.97	3.82	13.46
" protein,	11.11	31.60	26.16
Non-nitrogenous extract matter,	82.17	57.73	54.52
	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Corn Meal.	Skim-milk.*	Gluten Feed.
Moisture,	13.96	89.78	8.97
Nitrogen,	1.529	0.52	3.81
Phosphoric acid,	0.707	0.19	0.69
Potassium oxide,	0.435	0.20	0.42
Valuation per 2,000 pounds,	$5 76	$1 95	$12 57

* One quart equals 2.17 pounds.

Conclusions.

1. The average weight of the young pigs at the beginning of the experiment was 33 pounds per head, and their average weight at the close of the experiment was 191 pounds per head.

2. The experiment extended over 122 days. The daily gain in live weight averaged per head 1.56 pounds.

3. The total cost of feed consumed per pound of dressed weight produced averaged 5.8 cents, while the net cost averaged 4.2 cents. The obtainable manurial refuse amounted to two-fifths of the market cost of the diet consumed.

4. The dressed pork sold in our local markets at $6\frac{1}{2}$ cents per pound.

Pig No. 1.

Feeding Periods.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
March 23 to May 10,	34.12	273.00	-	1:3.10	35.00	71.50	0.76
May 10 to June 21,	63.00	252.00	54.37	1:3.88	71.50	130.50	1.40
June 21 to July 28,	119.81	222.00	36.56	1:4.69	130.50	184.50	1.46

Total Amount of Feed consumed from March 23, 1892, to July 28, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
216.93 pounds corn meal,	186.65	$2 60	$0 62
747.00 quarts skim-milk,	76.34	3 36	1 58
90.93 pounds gluten feed,	82.77	1 05	0 57
	345.76	$7 01	$2 77

	Pounds.
Live weight of animal at the beginning of the experiment,	35.00
Live weight of animal at the time of killing,	184.50
Live weight gained during the experiment,	149.50
Dressed weight of animal,	154.00
Loss in weight by dressing, 16.53 per cent., or	30.50
Dressed weight gained during the experiment,	124.79

Pounds of dry matter fed produced 1 pound of live weight, 2.31.

Pounds of dry matter fed produced 1 pound of dressed weight, 2.77.

Cost of feed per pound of dressed weight gained, 5.62 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of manurial value, 4.06 cents.

Pig No. 2.

Feeding Periods.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
March 23 to May 10, . . .	34.12	273.00	-	1:3.10	33.00	72.50	0.82
May 10 to June 21, . . .	63.00	252.00	55.12	1:3.88	72.50	133.50	1.45
June 21 to July 28, . . .	128.44	222.00	45.19	1:4.75	133.50	197.00	1.72

Total Amount of Feed consumed from March 23, 1892, to July 28, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
225.56 pounds corn meal, . . .	194.07	$2 71	$0 65
747.00 quarts skim-milk, . . .	76.34	3 36	1 58
100.31 pounds gluten feed, . .	91.31	1 15	0 63
	361.72	$7 22	$2 86

	Pounds.
Live weight of animal at the beginning of the experiment, .	33.00
Live weight of animal at the time of killing, ...	197.00
Live weight gained during the experiment, ...	164.00
Dressed weight of animal, ...	144.00
Loss in weight by dressing, 26.90 per cent., or	53.00
Dressed weight gained during the experiment, ...	119.88

Pounds of dry matter fed produced 1 pound of live weight, 2.21.

Pounds of dry matter fed produced 1 pound of dressed weight, 3.02.

Cost of feed per pound of dressed weight gained, 6.02 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of manurial value, 4.35 cents.

Pig No. 3.

Feeding Periods.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
March 23 to May 10,	34.12	273.00	-	1:3.10	34.50	71.50	0.77
May 10 to June 21,	63.00	252.00	52.87	1:3.88	71.50	125.50	1.29
June 21 to July 28,	128.37	222.00	45.12	1:4.75	125.50	196.50	1.91

Total Amount of Feed consumed from March 23, 1892, to July 28, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
229.47 pounds corn meal,	197.44	$2 75	$0 66
747.00 quarts skim-milk,	76.34	3 36	1 58
97.99 pounds gluten feed,	89.20	1 12	0 61
	362.98	$7 23	$2 85

	Pounds.
Live weight of animal at the beginning of the experiment,	34.50
Live weight of animal at the time of killing,	196.00
Live weight gained during the experiment,	161.50
Dressed weight of animal,	148.00
Loss in weight by dressing, 24.49 per cent., or	48.00
Dressed weight gained during the experiment,	121.95

Pounds of dry matter fed produced 1 pound of live weight, 2.25.

Pounds of dry matter fed produced 1 pound of dressed weight, 2.98.

Cost of feed per pound of dressed weight gained, 5.93 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of manurial value, 4.29 cents.

Pig No. 4.

Feeding Periods.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
March 23 to May 10, . . .	34.12	273.00	–	1:3.10	33.00	73.75	0.85
May 10 to June 21, . . .	63.00	252.00	55.12	1:3.88	73.75	133.50	1.42
June 21 to July 28, . . .	122.62	222.00	39.37	1:4.72	133.50	192.50	1.59

Total Amount of Feed consumed from March 23, 1892, to July 28, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
219.74 pounds corn meal, . . .	189.06	$2 64	$0 63
747.00 quarts skim-milk, . . .	76.34	3 36	1 58
94.49 pounds gluten meal, . .	86.01	1 08	0 59
	351.41	$7 08	$2 80

	Pounds.
Live weight of animal at the beginning of the experiment, .	33.00
Live weight of animal at the time of killing, ...	192.50
Live weight gained during the experiment, ...	159.50
Dressed weight of animal, ...	148.00
Loss in weight by dressing, 23.12 per cent., or	44.50
Dressed weight gained during the experiment, ...	122.62

Pounds of dry matter fed produced 1 pound of live weight, 2.20.

Pounds of dry matter fed produced 1 pound of dressed weight, 2.87.

Cost of feed per pound of dressed weight gained, 5.77 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of manurial value, 4.18 cents.

Pig No. 5.

FEEDING PERIODS.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim milk consumed (Quarts).	Total Amount of Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
March 23 to May 10, ...	34.12	273.00	–	1:3.10	30.00	70.25	0.84
May 10 to June 21, ...	63.00	252.00	39.37	1:3.88	70.25	120.00	1.18
June 21 to July 28, ...	124.62	222.00	41.37	1:4.73	120.00	183.25	1.71

Total Amount of Feed consumed from March 23, 1892, to July 28, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
221.74 pounds corn meal, . .	190.79	$2 66	$0 64
747.00 quarts skim-milk, . . .	76.34	3 36	1 58
80.74 pounds gluten meal, . .	73.50	0 93	0 51
	340.63	$6 95	$2 73

	Pounds.
Live weight of animal at the beginning of the experiment, .	30.00
Live weight of animal at the time of killing, ...	183.25
Live weight gained during the experiment, ...	153.25
Dressed weight of animal, ...	144.00
Loss in weight by dressing, 21.42 per cent., or	39.25
Dressed weight gained during the experiment, ...	120.42

Pounds of dry matter fed produced 1 pound of live weight, 2.22.

Pounds of dry matter fed produced 1 pound of dressed weight, 2.91.

Cost of feed per pound of dressed weight gained, 5.77 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of manurial value, 4.18 cents.

Pig No. 6.

Feeding Periods.	Total Amount of Corn Meal consumed (Pounds).	Total Amount of Skim-milk consumed (Quarts).	Total Amount of Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
March 23 to May 10, . . .	34.12	273.00	-	1:3.10	35.00	79.50	0.93
May 10 to June 21, . . .	63.00	252.00	43.50	1:3.88	79.50	143.50	1.52
June 21 to July 28, . . .	131.81	222.00	48.56	1:4.45	143.50	200.75	1.55

Total Amount of Feed consumed from March 23, 1892, to July 28, 1892.

	Dry Matter (Pounds).	Cost.	Manurial Value.
228.93 pounds corn meal, . . .	196.97	$2 75	$0 66
747.00 quarts skim-milk, . . .	76.34	3 36	1 58
92.06 pounds gluten feed, . .	83.80	1 06	0 58
	357.11	$7 17	$2 82

	Pounds.
Live weight of animal at the beginning of the experiment, .	35.00
Live weight of animal at the time of killing, ...	200.75
Live weight gained during the experiment, ...	165.75
Dressed weight of animal, ...	157.00
Loss in weight by dressing, 21.79 per cent., or	43.75
Dressed weight gained during the experiment, ...	129.63

Pounds of dry matter fed produced 1 pound of live weight, 2.15.

Pounds of dry matter fed produced 1 pound of dressed weight, 2.75.

Cost of feed per pound of dressed weight gained, 5.53 cents.

Net cost of feed per pound of dressed weight gained after deducting 30 per cent. of manurial value, 4.01 cents.

V.

COMPILATION OF THE AMOUNT OF DIGESTIBLE NUTRIENTS CONSUMED DAILY IN THE DIFFERENT FEEDING EXPERIMENTS MADE AT THE MASSACHUSETTS STATE EXPERIMENT STATION (Compiled by Dr. J. B. Lindsey).

1886–92.

Milch Cows — Steers — Lambs.

1. *Milch Cows.*

Number of Cows.	Kind of Feed.	Total Dry Matter (Pounds).	Digestible Matter consumed Daily per 1,000 Pounds Live Weight.				Nutritive Ratio.
			Organic Matter (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	
	Winter Season.						
	1886.						
2	Grain and hay, ...	27.83	16.78	1.98	14.64	0.48	1:8.0
2	Grain, hay and corn fodder, . . .	24.61	16.49	1.96	14.00	0.53	1:7.8
2	Grain, hay and ensilage, ...	19.73	13.01	1.35	11.16	0.47	1:9.1
2	Grain, hay and roots, ...	26.70	17.94	2.29	15.22	0.42	1:7.1
	General average, ...	24.72	16.05	1.89	13.75	0.47	1:7.9
	1887.						
3	Grain and hay, ...	28.45	18.41	2.53	15.20	0.59	1:6.7
3	Grain, hay and ensilage, ...	22.17	16.29	2.48	13.27	0.87	1:6.2
3	Grain and corn fodder, ...	24.35	17.18	2.11	14.50	0.57	1:7.6
3	Grain, hay and carrots, ...	22.69	16.41	2.54	13.44	0.60	1:5.9
	General average, ...	24.42	17.07	2.42	14.10	0.66	1:6.6
	1888.						
6	Grain and hay, ...	25.47	16.12	2.35	13.40	0.58	1:6.3
6	Grain and corn fodder, ...	23.80	16.33	2.43	13.23	0.67	1:6.2
6	Grain and corn stover, ...	19.28	13.69	2.21	10.89	0.58	1:5.6
6	Grain, hay and ensilage, . . .	21.63	14.71	2.30	11.83	0.59	1:6.0
	General average, ...	22.54	15.21	2.32	12.34	0.61	1:6.0

1. Milch Cows — Continued.

Number of Cows.	Kind of Feed.	Total Dry Matter (Pounds).	Digestible Matter consumed Daily per 1,000 Pounds Live Weight.				Nutritive Ratio.
			Organic Matter (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	
	Winter Season.						
	1889.						
9	Grain and hay, ...	26.64	17.46	2.56	14.39	0.51	1:6.1
6	Grain and corn fodder, ...	18.95	14.39	2.23	11.69	0.47	1:5.8
5	Grain and corn stover, ...	19.42	14.77	2.16	12.15	0.46	1:6.1
7	Grain, hay and ensilage, ...	24.58	17.83	2.54	14.41	0.88	1:6.5
5	Grain, hay and carrots, ...	22.52	16.53	2.42	13.62	0.48	1:6.2
5	Grain, hay and sugar beets, . . .	25.38	19.09	2.78	15.82	0.49	1:6.1
	General average, ...	22.91	16.68	2.45	13.68	0.55	1:6.1
	1890.						
6	Grain and rowen,*	27.31	17.25	3.11	13.47	0.68	1:4.88
3	Grain, hay and ensilage, ...	26.32	18.26	2.69	14.57	0.99	1:6.30
5	Grain, corn fodder and carrots, . .	21.87	15.08	2.62	12.07	0.49	1:5.10
6	Grain, corn stover and carrots, . .	22.16	16.20	2.72	12.91	0.57	1:5.31
5	Grain, hay and turnips, ...	25.70	17.09	2.81	13.73	0.54	1:5.40
	General average, ...	24.67	16.78	2.80	13.35	0.65	1:5.35
	1891.						
6	Grain and hay,*	24.98	16.17	2.39	13.33	0.57	1:6.15
7	Grain and rowen.	26.52	16.30	3.09	13.07	0.78	1:5.00
5	Grain, hay and corn and soja bean ensilage.	29.10	19.14	3.77	14.29	1.08	1:4.50
5	Grain and corn stover, ...	22.36	15.91	2.31	12.98	0.61	1:6.30
	General average, ...	25.74	16.88	2.89	13.42	0.76	1:5.30
	Wolff's standard, ...	–	15.93	2.66	12.67	0.60	1:5.30
	Summer Season.						
	1887.						
5	Grain and hay, ...	26.85	16.44	1.79	14.06	0.51	1:8.52
3	Grain, hay and vetch and oats (green), .	31.39	17.46	2.32	13.36	0.67	1:6.53
3	Grain, hay and cow-pea, ...	34.17	21.33	2.23	18.50	0.69	1:9.07
3	Grain, hay and serradella, . . .	33.02	17.40	2.67	14.13	0.60	1:5.85
	General average, ...	31.36	18.16	2.25	15.01	0.62	1:7.40

* The *absolute quantity* of the different grains was constant throughout the year's experiment. At times, however, one kind was substituted for another.

1. *Milch Cows* — Concluded.

Number of Cows.	Kind of Feed.	Total Dry Matter (Pounds).	Digestible Matter consumed Daily per 1,000 Pounds Live Weight.				Nutritive Ratio.
			Organic Matter (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	
	Summer Season.						
	1888.						
5	Grain and hay,	27.74	17.25	2.60	14.08	0.58	1:6.00
5	Grain and rowen,	29.50	18.49	3.27	14.56	0.63	1:4.93
5	Grain, hay and vetch and oats,	30.49	18.98	3.05	15.20	0.59	1:5.55
5	Grain, hay and cow-pea,	29.88	19.04	3.66	15.04	0.65	1:4.55
	General average,	29.40	18.44	3.14	14.72	0.61	1:5.20
	1889.						
6	Grain and hay,	25.19	16.10	2.35	13.44	0.50	1:6.25
6	Grain, hay and serradella,	25.88	17.05	3.17	13.37	0.58	1:4.57
6	Grain, hay and vetch and oats,	23.41	15.01	2.15	12.34	0.52	1:6.34
6	Grain, hay and cow-pea,	25.33	17.03	2.49	13.94	0.60	1:6.20
	General average,	24.95	16.30	2.54	13.27	0.55	1:5.80
	1890.						
6	Grain and rowen,	28.42	18.13	3.26	14.17	0.70	1:4.9
6	Grain, hay and vetch and oats,	27.35	17.58	2.76	14.19	0.64	1:5.7
6	Grain, hay and soja bean,	31.05	19.36	3.59	15.62	0.65	1:4.8
	General average,	28.94	18.36	3.20	14.66	0.66	1:5.1
	1891.						
5	Grain, rowen and vetch and oats,	33.47	19.14	2.77	15.59	0.78	1:6.3
5	Grain, rowen and soja bean,	29.66	18.84	3.32	14.37	0.65	1:5.0
	General average,	31.56	18.94	3.04	14.98	0.71	1:5.6
	Wolff's standard,	–	15.93	2.66	12.67	0.60	1:5.3

2. *Steers.*

Number of Steers.	Age (Years).	Kind of Feed.	Total Dry Matter (Pounds).	Digestible Matter consumed Daily per 1,000 Pounds Live Weight.				Nutritive Ratio.
				Organic Matter (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	
		1889-90.						
2	1	Grain and corn stover, . . .	13.72	9.83	1.78	7.61	0.43	1:4.8
2	1	Grain and corn ensilage, . . .	25.91	18.21	3.24	13.95	1.15	1:5.2
2	1	Grain and corn fodder, . . .	19.63	13.63	2.47	10.56	0.60	1:4.9
2	1	Grain, corn stover and sugar beets, .	14.86	11.15	2.13	8.54	0.48	1:4.6
		General average, ...	18.53	12.95	2.41	10.16	0.67	1:4.9
		1890-91.						
3	1	Grain and hay, ...	20.54	12.41	2.45	9.36	0.59	1:4.5
3	1	Grain, hay and roots, ...	21.89	13.50	2.79	10.08	0.62	1:4.5
3	1	Grain, hay and ensilage, . . .	20.49	12.50	2.75	9.03	0.72	1:4.0
		General average, ...	20.97	12.80	2.66	9.49	0.64	1:4.3
		Wolff's standard, ...	-	15.08	2.17	12.54	0.37	1:6.25
		1889-90.						
2	2	Grain and corn stover, . . .	11.95	8.49	1.42	6.73	0.34	1:5.5
2	2	Grain and corn ensilage, . . .	20.79	14.22	2.02	11.33	0.86	1:6.6
2	2	Grain and corn fodder, . . .	15.51	10.89	1.94	8.48	0.47	1:4.9
		General average, ...	16.10	11.20	1.79	8.85	0.56	1:5.7
		1890-91.						
2	2	Grain, hay and turnips, . . .	19.87	12.68	2.55	9.59	0.55	1:4.3
2	2	Grain and ensilage, ...	18.33	11.75	2.32	8.84	0.59	1:4.4
2	2	Grain and hay, ...	19.36	11.69	2.32	8.81	0.56	1:4.4
		General average, ...	19.19	12.04	2.39	9.08	0.57	1:4.4
		1891-92.						
3	2	Grain, hay and roots, ...	16.75	11.19	1.82	8.90	0.47	1:5.6
3	2	Grain and ensilage, ...	13.48	9.44	1.63	7.24	0.36	1:5.3
3	2	Grain and corn stover, . . .	14.23	9.92	1.65	7.83	0.44	1:5.4
		General average, ...	14.82	10.18	1.70	7.99	0.42	1:5.4
		Wolff's standard, ...	-	15.08	2.17	12.54	0.37	1:6.25

3. *Lambs.*

Number of Lambs.	Age (Months).	Kind of Feed.	Total Dry Matter (Pounds).	Digestible Matter consumed Daily per 1,000 Pounds Live Weight.				Nutritive Ratio.
				Organic Matter (Pounds).	Protein (Pounds).	Carbohydrates (Pounds).	Fat (Pounds).	
		1889-90.						
		Narrow Ration.						
3	8-12	Grain and rowen, ...	31.37	20.15	3.88	15.38	0.89	1:4.5
3	8-12	Grain, rowen and corn ensilage, .	28.58	19.53	3.47	15.03	1.03	1:5.1
3	8-12	Grain and corn ensilage, . . .	23.68	15.81	2.89	12.90	1.02	1:5.3
		General average, . . .	27.88	18.49	3.41	14.44	0.98	1:5.0
		Wide Ration.						
3	8-12	Grain and rowen, ...	27.48	14.60	2.31	14.68	0.61	1:7.0
3	8-12	Grain, rowen and ensilage, . .	21.42	14.50	1.71	12.15	0.64	1:8.0
3	8-12	Grain and ensilage, ...	22.26	15.54	2.55	12.05	0.94	1:5.6
		General average, . . .	23.72	14.88	2.19	12.96	0.73	1:6.8
		1890-91.						
		Wide Ration.						
3	8-12	Grain and rowen, ...	28.85	19.16	3.09	15.26	0.81	1:5.7
3	8-12	Grain, rowen and ensilage, . .	23.60	17.04	2.16	14.24	0.64	1:7.3
		General average, . . .	26.22	18.10	2.62	14.75	0.73	1:6.5
		Narrow Ration.						
3	8-12	Grain and rowen, ...	31.90	19.93	3.92	15.09	0.92	1:4.45
3	8-12	Grain, rowen and ensilage, . .	24.59	16.40	2.88	12.75	0.77	1:5.10
		General average, . . .	28.24	18.16	3.40	13.92	0.84	1:4.77
		1891-92.						
6	8-12	Grain and rowen, ...	22.38	14.38	2.62	11.05	0.71	1:4.8
6	8-12	Grain, rowen and ensilage, . .	20.38	13.53	2.33	10.49	0.71	1:5.2
6	8-12	Grain, rowen and mangolds, . .	20.19	14.55	2.49	11.54	0.52	1:5.2
		General average, . . .	20.98	14.12	2.48	11.03	0.65	1:5.1
		Wolff's standard, . . .	–	17.58	3.08	14.08	0.42	1:5.0

PART II.

ON

FIELD EXPERIMENTS

AND

OBSERVATIONS IN VEGETABLE PHYSIOLOGY

AND

PATHOLOGY.

1. Field Experiments to ascertain the Effect of the Exclusion of Every Form of Nitrogen-containing Manurial Matter from the Fertilizer applied for the Production of a Leguminous Crop — Soja Bean — on its Yield per Acre (Field A).
2. Field Experiments with Prominent Varieties of Grasses and with Grass Mixtures under fairly Corresponding Circumstances (Field B).
3. Field Experiments regarding the Effect of Different Combinations of Commercial Fertilizers on the Yield of Some Prominent Garden Crops (Field C).
4. Observations regarding the Adaptation of a Variety of More or Less Reputed Fodder Plants new to our Section of the Country (Field D).
5. Field Experiments with Different Commercial Phosphates, to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates (Field F).
6. Field Experiments with Mixed Forage Crops for Green Fodder and Hay, Vetch and Oats, Canada Peas and Oats.
7. Observations on Permanent Grass Lands — Meadows.
8. Report on General Farm Work.
9. Report of Prof. James E. Humphrey on Various Diseases of Plants, with Observations in the Field and Vegetation House.

1. Field Experiments carried on for the Purpose of ascertaining the Effect of the Exclusion of Every Form of Nitrogen-containing Manurial Matter from the Fertilizer applied for the Production of a Leguminous Crop (Clover-like Plants) on the Yield, as compared with the Results obtained when a Liberal Amount of Various Nitrogen-containing Manurial Substances is applied under Otherwise Corresponding Circumstances for the Same Purpose.*

Field A.

The unbroken record of this field extends over more than twenty years. The systematic treatment of the soil, as far as modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-eighth of an acre each), of a uniform size and shape, one hundred and thirty feet long and thirty feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

Since 1889 the main object of observations upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial. The treatment of the soil adopted in preceding years favored this new project for field observations.

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of

* Soja bean served for the observation.

nitrogen-containing manurial substances on the crop under cultivation, while the remaining ones received as before a definite amount of nitrogen in the same form in which they had received it in preceding years; namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood. A corresponding amount of available nitrogen was applied in all these cases.

Aside from the difference regarding the nitrogen supply, all plats were treated alike. They each received without an exception a corresponding amount of available phosphoric acid and of potassium oxide. The phosphoric acid was supplied in form of dissolved bone-black, and the potassium oxide either in form of muriate of potash or of potash-magnesia sulphate. From 120 to 130 pounds of potassium oxide, from 80 to 85 pounds of available phosphoric acid and from 40 to 50 pounds of available nitrogen were supplied per acre.

One plat marked 0 received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

This course in the general management of the experiment has been followed thus far for three successive years — 1889, 1890 and 1891 — in connection with different crops: —

Corn (maize), in 1889 (see seventh annual report); oats, in 1890 (see eighth annual report); rye, in 1891 (see ninth annual report).

The following tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early as circumstances permitted. They were slightly harrowed under before the seed was planted in rows by a seed drill. Each plat received the same amount of seed.

PLATS.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

1892. — The field was ploughed April 19 and 20. The barn-yard manure was applied to Plat 0 April 15; the remaining plats, 1–10, received May 6 their different mixtures of commercial fertilizers, broadcast, after which the entire field was harrowed and rolled. The seed was sown in drills two and one-half feet apart May 16, at the rate of seven pounds to each plat.

The soja bean seed, a late maturing variety, was bought of J. M. Thorburn & Co., New York City, at eight cents per pound. The crop was cut for ensilage September 8.

The young plants appeared above ground May 28; they were cultivated and hoed June 3 and July 17, when they

shaded the ground sufficiently to prevent any serious appearance of weeds. The variation in the color of the crop was quite marked in different plats during the earlier stages of its growth. Those plats which received an addition of nitrogen in form of nitrate of soda showed a deeper green color than those which received other forms of nitrogen, in particular, sulphate of ammonia; while those that received no addition of nitrogen maintained a light green color until the close of the season.

Height of the Plants upon Different Plats during the Season.

Plats.	July 8.	July 15.	July 22.	July 29.	Aug. 5.	Aug. 12.	Aug. 19.	Aug. 26.	Sept. 2.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Plat 0,	13	17	25	30	31	36	41	44	44
Plat 1,	12	17	25	30	33	38	40	44	44
Plat 2,	13	17	24	31	33	37	40	43	45
Plat 3,	13	16	24	30	35	38	41	45	46
Plat 4,	12	14	21	29	29½	31	34	38	39
Plat 5,	11	15	21	28	30	33	36	40	42
Plat 6,	12	16	24	30	32	34	39	42	43
Plat 7,	10	13	18	24	27	32	35	40	41
Plat 8,	8	9	13	20	22	23	29	33	35
Plat 9,	9	10	18	23	26	26	32	37	39
Plat 10,	12	14	21	27	30	34	39	42	43

Yield of Crop on Different Plats.

Cut September 7 and 8.	Weight of Green Soja Bean (Pounds).	Yield per Acre (Tons).
Plat 0,	2,210	11.050
Plat 1,	2,290	11.450
Plat 2,	2,290	11.450
Plat 3,	2,090	10.450
Plat 4,	1,440	7.200
Plat 5,	1,935	9.675
Plat 6,	1,970	9.850
Plat 7,	1,430	7.150
Plat 8,	1,450	7.250
Plat 9,	1,460	7.300
Plat 10,	1,490	7.450

Analysis of the Plants from Plat 0.

	Per Cent.
Moisture at 100° C.,	73.20
Dry matter,	26.80
	100.00

Analysis of Dry Matter.

Crude ash,	6.80
" cellulose,	30.54
" fat,	2.29
" protein,	6.82
Nitrogen-free extract matter,	53.55
	100.00

An examination of the above tabular statement of the yield of each plat shows, in every case where no additional nitrogen in any form has been applied in connection with the phosphoric acid and potash used as fertilizer (plats 4, 7, 9), a decided falling off in the yield; fully one-third less than where barn-yard manure and nitrate of soda have furnished the nitrogen supply (plats 0, 1, 2, 3).

Plat 8 shows the same exceptional condition which has been noticed in preceding years, when it seriously suffered from the attack of some parasitic enemy. The low yield of Plat 10 is evidently due to the use of a lower rate of seed, being the first plat to adjust the seed drill for a definite amount of seed.

Conclusion. — *The importance of a liberal additional supply of nitrogen to the soil for a successful production of farm crops under otherwise corresponding circumstances finds a strong confirmation in our late experiments in that direction, as may be noticed in the subsequent compiled tabular statement of the results of three years' observations.*

Summary of Three Years' Observations upon Field A (1890–92).

Number of Plat.	MANURIAL MATTER APPLIED.	1890. Yield of Oats. Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	1891. Yield of Rye. Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Yield of Grain (Pounds).	Yield of Straw (Pounds).	1892. Yield of Green Soja Bean (Pounds).
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black,	315	38.10	61.90	470	30.21	69.79	142	328	2,210
Plat 1,	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	362	35.36	64.64	570	27.02	72.98	154	416	2,290
Plat 2,	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	365	35.34	64.66	525	25.52	74.48	134	391	2,290
Plat 3,	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	345	33.62	66.38	475	27.37	72.63	130	345	2,090
Plat 4,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone black (= 8.5 lbs. available phosphoric acid),	260	34.61	63.39	390	27.44	72.56	107	283	1,440
Plat 5,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	360	39.20	60.80	530	27.36	72.64	145	385	1,935
Plat 6,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone black (= 8.5 lbs. available phosphoric acid),	385	32.21	67.79	400	25.50	74.50	102	298	1,970
Plat 7,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	320	34.40	65.60	450	24.22	75.78	109	341	1,430
Plat 8,	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	220	26.82	73.18	-	-	-	-	-	1,450
Plat 9,	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	290	34.83	65.17	425	25.65	74.35	109	316	1,460
Plat 10,	43 lbs. dried blood, (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid),	395	35.44	64.56	425	29.41	70.59	125	300	1,490

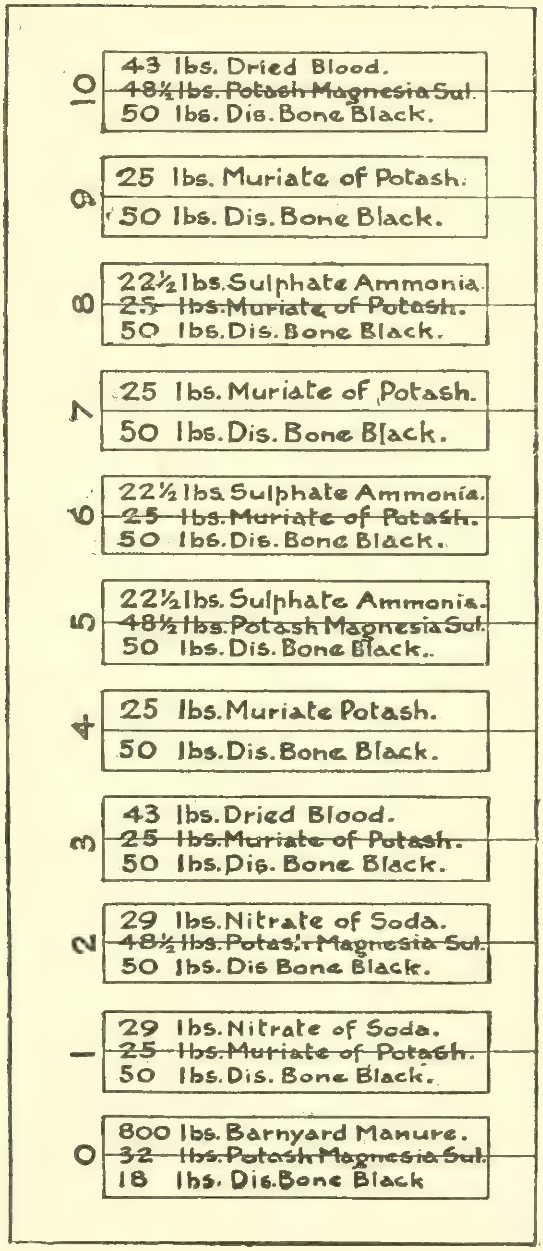
The crop when harvested, September 7 and 8, to serve for the production of a mixed ensilage (soja bean and fodder corn), showed no signs of seed pods or blossoms. It differed in this respect decidedly from other early maturing varieties, white and black soja beans, which have been raised and described by us in preceding annual reports.

The advantage, if any, of this new variety of soja bean consists in the large amount of vegetable matter it produces, as compared with the early maturing varieties.

[1. Analysis of an early variety of soja bean with pods (whole plant); 2. Analysis of soja bean seed; 3. Analysis of soja bean straw (matured plant, early variety).]

	Per Cent		
	1.	2.	3.
Moisture at 100° C.,	10.90	14.17	7.63
Dry matter,	89.10	85.83	92.37
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	6.90	5.84	10.72
" cellulose,	22.79	6.02	36.80
" fat,	6.77	20.19	3.49
" protein,	16.68	33.97	5.34
Nitrogen-free extract matter,	46.86	33.98	43.65
	100.00	100.00	100.00

Field "A," 1892.



SCALE, 4 RODS TO 1 INCH.

2. Field Experiments with Prominent Varieties of Grasses, raised either Single or in Mixture, under Otherwise Corresponding Conditions, to ascertain their Economical Value as far as Yield and Composition are concerned (1892).

Field B.

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21. From 1884 to 1889 every alternate plat received annually the same kind and the same amount of fertilizer, — 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The space of five feet left between the different succeeding plats has been kept clean from any growth by a constant use of the cultivator, and received at no time any kind of manure.

The details of the work carried on upon Field B have been thus far reported from year to year in our annual reports. The chemical analyses of the crops raised upon this field, on account of the amount of work involved, have been quite frequently published in later bulletins or in annual reports of the succeeding year.

A material change in the above-stated management of the field was made in 1889, with reference to the previously unmanured plats, 12, 14, 16, 18 and 20; they were subsequently annually manured in exactly the same manner as the remaining plats, receiving per acre 600 pounds of fine-ground bone and 200 pounds of muriate of potash. The character of the crops raised upon the various plats from 1888 to 1892 may be seen from the following tabular statement : —

Plats.	1889.	1890.	1891.
Plat 11,	Kentucky blue-grass,	Kentucky blue-grass, sown Sept. 24, 1889,	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 12,	Kentucky blue-grass,	Kentucky blue-grass, sown Sept. 24, 1889,	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 13,	Red-cob ensilage corn,	Red top, sown Sept. 24, 1889,	English rye-grass, north, sown Sept. 29, 1889. Italian rye-grass, south, sown Sept. 29, 1889.
Plat 14,	Red-cob ensilage corn,	Red top, sown Sept. 24, 1889,	English rye-grass and red top, sown Sept. 29, 1890.
Plat 15,	Bokhara clover (*Melilotus alba*), Sainfoin (*Onobrychis sativa*),	Bokhara clover, sown May 8, 1889, Sainfoin, sown May 8, 1889,	Herds grass and red top, sown April 23, 1890.
Plat 16,	Bokhara clover, Sainfoin,	Rhode Island bent (*Agrostis alba*), sown Sept. 25, 1889,	Italian rye-grass and red top, sown April 23, 1890.
Plat 17,	Meadow fescue,	Meadow fescue, sown September, 1887,	Meadow fescue, sown September, 1887.
Plat 18,	Red-cob ensilage corn,	Meadow fescue, sown September, 1889,	Meadow fescue, sown Sept. 29, 1890.
Plat 19,	Alsike clover, Medium red clover,	Herds grass, sown September, 1889,	Herds grass, sown Sept. 25, 1889.
Plat 20,	Red-cob ensilage corn,	Red top and herds grass mixed, sown September, 1889,	Herds grass and red top, sown Sept. 29, 1890.
Plat 21,	Corn (variety, Clark),	Meadow fescue and herds grass, mixed, sown September, 1889,	Meadow fescue and red top, sown Sept. 29, 1890.

1891. — Previous to the year 1891 other crops than grasses have been cultivated upon some plats at times. Of late none but single grasses or mixtures of reputed grasses have been planted. The single grasses are raised as in previous years, in rows two feet apart; grass mixtures are seeded down broadcast. The manure in case of single grasses is applied by hand between the rows, and is subsequently slightly ploughed in by means of a cultivator; in case of grass mixtures the manure is applied as top dressing early in the spring. In both cases the first manure is applied broadcast and ploughed under before seeding down the grass.

Crops raised in 1892.

Plats.	1892.
Plat 11, .	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 12, .	Kentucky blue-grass and red top, sown Sept. 18, 1891.
Plat 13, .	English rye-grass and Italian rye-grass, sown Sept. 29, 1890.
Plat 14, .	English rye-grass and red top, sown Sept. 29, 1890.
Plat 15, .	Herds grass and red top, sown April 23, 1891.
Plat 16, .	Italian rye-grass and red top, sown April 23, 1891
Plat 17, .	Meadow fescue, sown Sept. 25, 1887.
Plat 18, .	Meadow fescue, sown Sept. 29, 1890.
Plat 19, .	Herds grass, sown Sept. 25, 1889.
Plat 20, .	Herds grass and red top, sown Sept. 29, 1890.
Plat 21, .	Meadow fescue and herds grass, sown Sept. 18, 1891.

Area of Each Plat, Two-fifteenths Acre.	Yield of Hay, First and Second Cut (Pounds).	Rate per Acre (Pounds).
Plat 11, sown Sept. 24, 1889, ...	335	2,513
Plat 12, sown Sept. 18, 1891, ...	365	2,737
Plat 13, sown Sept. 29, 1890, ...	255	1,913
Plat 14, sown Sept. 29, 1890, ...	225	1,688
Plat 15, sown April 23, 1891, ...	565	4,238
Plat 16, sown April 23, 1891, ...	565	4,238
Plat 17, sown Sept. 25, 1887, ...	475	3,563
Plat 18, sown Sept. 29, 1890, ...	490	3,675
Plat 19, sown Sept. 25, 1889, ...	610	4,575
Plat 20, sown Sept. 29, 1890, ...	285	2,138
Plat 21, sown Sept. 18, 1891, ...	355	2,663
Total, ...	4,525	

Field "B," 1892.

21	Meadow Fescue and Herds Grass.
20	Herds Grass and Red Top.
19	Herds Grass.
18	Meadow Fescue.
17	Meadow Fescue.
16	Italian Rye-grass and Red Top.
15	Herds Grass and Red Top.
14	English Rye-grass and Red Top.
13	English Rye-grass and Italian Rye-grass.
12	Kentucky Blue-grass and Red Top.
11	Kentucky Blue-grass.

Scale, 4 rods to 1 inch.

3. Field Experiments regarding the Effect of Different Combinations of Commercial Fertilizers on the Yield and the Character of Several Prominent Garden Crops (1892).

Field C.

1891. — The observations upon Field C with different combinations of commercial fertilizers on the yield and character of some prominent garden crops began during the spring of 1891. The portion of Field C devoted to this experiment during 1891 consisted of one-half of its entire area, running from east to west along its south side (328 feet long and 88 feet wide). It was subdivided into five plats of corresponding size and shape (88 by 62 feet), one-eighth of an acre. These plats were separated from each other and from other cultivated land adjoining by a space of five feet of unmanured and unseeded land. The soil is several feet deep, and consists of a rather light loam in a good state of cultivation; 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre were used for several years previous to 1891 as the annual manure supply. The field slopes gently from west to east. The plats were numbered 1, 2, 3, 4, 5, beginning at the east end of the field. Each plat received during the spring of 1891 a manurial mixture of its own as fertilizer.

The difference of the fertilizers applied consisted essentially in the circumstance that nitrogen and potash were used in several of them in different forms. All plats received practically the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others received their nitrogen in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (in our market 95 per cent.). The subsequent tabular statement shows the quantities of the manurial substances applied to different plats: —

Plat 1, ...	75 pounds dried blood. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 2, ...	47 pounds nitrate of soda. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 3, ...	38 pounds sulphate of ammonia. 30 pounds muriate of potash. 40 pounds dissolved bone-black.
Plat 4, ...	47 pounds nitrate of soda. 30 pounds high-grade sulphate of potash. 40 pounds dissolved bone-black.
Plat 5, ...	38 pounds sulphate of ammonia. 30 pounds high-grade sulphate of potash. 40 pounds dissolved bone-black.

		Pounds.
Per acre:	Phosphoric acid,	50.4
	Nitrogen,	60.0
	Potassium oxide,	120.0

The different fertilizers were applied broadcast, and subsequently slightly ploughed under, in all cases on the same day (April 22, 1891). All plats were planted in the same order with the same kind of garden crops (eight). Every plat was either planted with young plants or was sown with the seed, as circumstances dictated, each kind on the same day and in the same manner. The young plants used for the experiment were raised under corresponding conditions from seed in a hot-bed. The different kinds of garden crops were arranged in the following order, beginning on the east side of each plat: —

Lettuce, White Tennis Ball, one row.
Spinach, Long Standing and Bloomingdale, one row each.
Beets, Egyptian and Dewings, one row each, or two of a kind.
Celery, White Plume, one row.
Kohlrabi, two rows.
Cabbage, Red Dutch and several white varieties, three rows in all.
Tomatoes, Boston Market, two rows.
Potatoes, Beauty of Hebron, five rows.

The details of the results are recorded in our ninth annual report. Being the first year's observation, no serious attempt was made to account for the differences in the yield upon different plats.

1892. — During the spring of 1892 it was thought best to make such alteration in the location of the plats as would

secure as far as practicable a corresponding level position for all of them, and thereby remove the objection of the possible influence of a more or less inclined position and different state of moisture of one or the other on the results.

For this purpose the entire width of Field C on its western termination was selected for the future trial. The field thus marked out covered an area 189 feet long and 164 feet wide. It was subdivided into six plats of equal size and shape (88 by 62 feet), corresponding thus in this particular with those in the preceding year. Three plats of the previous year, 3, 4 and 5, remained unchanged; their numbers were altered into 6, 5 and 4. The new plats were numbered 1, 2, 3, beginning at the west end of the field. The entire area was ploughed April 19, and subsequently staked out as above stated into six plats, with four feet unoccupied space between them. The below specified fertilizer mixture was applied to each plat broadcast, and the soil subsequently harrowed. On May 10 it was rolled. All the crops were planted in rows two and one-half feet apart; the different crops were seeded or planted each on the same day in all the plats. The crops were arranged in all plats in the same order, which, in the interest of a desirable rotation, differed from that in the preceding year (plats 4, 5, 6).

Plats.		Annual Supply of Manurial Substances.	Pounds.
Plat 1,	*First Year.*	Sulphate of ammonia,	38
		Muriate of potash,	30
		Dissolved bone-black,	40
Plat 2,		Nitrate of soda,	47
		Muriate of potash,	30
		Dissolved bone-black,	40
Plat 3,		Dried blood,	75
		Muriate of potash,	30
		Dissolved bone-black,	40
Plat 4,	*Second Year.*	Sulphate of ammonia,	38
		Sulphate of potash,	30
		Dissolved bone-black,	40
Plat 5,		Nitrate of soda,	47
		Sulphate of potash,	30
		Dissolved bone-black,	40
Plat 6,		Dried blood,	75
		Sulphate of potash,	30
		Dissolved bone-black,	40

Plats 1, 2 and 3 have been treated with the stated fertilizers this year only ; plats 4, 5 and 6 have been treated two years.

The following order in arranging the different crops was adopted in 1892, beginning in each plat at its west end. The rows run in all plats from south to north (88 feet long) : —

Two rows of celery, variety Dwarf Golden Heart.
Two rows of lettuce, variety Hanson.
Two rows of spinach, variety New Zealand.
Four rows of beets, variety Edmund's Blood Turnip.
Four rows of cabbages, variety Savoy (one row) ; variety Fottler's (two rows) ; variety Red Dutch (one row).
Two rows of tomatoes, variety Essex Hybrid.
Five rows of potatoes, variety Beauty of Hebron.

Potatoes were planted May 9 ; spinach and beets were sown May 10 ; lettuce and cabbage plants were set out May 13 ; tomato plants were set out May 21 ; celery plants were set out June 9.

The seeds in every case were taken from the same lot ; the young plants were raised under corresponding conditions in the same hot-bed, and a corresponding number transplanted in each plat. All plats were kept clean from weeds and treated in a like manner during the season. The crops were harvested whenever fit for the market. The subsequent tabular statements of the yield of the crops show the date of maturity and the quantity obtained at different dates : —

Yield of Celery (Variety Dwarf Golden Heart).

Plats.	Number of Perfect Heads.
Plat 1 (two rows),	46
Plat 2 (one row),	43
Plat 3 (one row),	69
Plat 4 (two rows),	61
Plat 5 (one row),	62
Plat 6 (one row),	52

The plants were set out June 9 ; they were harvested October 20.

Yield of Lettuce (Variety Hanson).

Plats.	Pounds.
Plat 1 (two rows; seventy heads),	41½
Plat 2 (two rows; seventy heads),	36
Plat 3 (two rows; seventy heads),	43
Plat 4 (two rows; seventy heads),	76
Plat 5 (two rows; seventy heads),	60
Plat 6 (two rows; seventy heads),	36

The plants were set out May 13; they were harvested July 1.

Yield of Spinach (Variety New Zealand).

Plats.	Pounds.
Plat 1 (two rows),	192
Plat 2 (two rows),	233
Plat 3 (two rows),	202
Plat 4 (two rows),	230
Plat 5 (two rows),	232
Plat 6 (two rows),	134

The seed was sown May 10; crop was harvested July 11.

Yield of Beets (Variety Edmund's Blood Turnip).

Plats.	Pounds.
Plat 1 (four rows),	350
Plat 2 (four rows),	345
Plat 3 (four rows),	515
Plat 4 (four rows),	455
Plat 5 (four rows),	509
Plat 6 (four rows),	495

The seed was sown May 10; crop was harvested October 14.

Yield of Cabbages.

Plats.	Savoy, One Row in Plat.	Fottler's, Two Rows in Plat.	Red Dutch, One Row in Plat.
	Pounds.	Pounds.	Pounds.
Plat 1,	100	534	201
Plat 2,	113	762	350
Plat 3,	116	576½	330
Plat 4,	107	458	325
Plat 5,	110	674	340
Plat 6,	107	586	241

The plants were set out May 13. Savoy cabbages were harvested August 8; Fottler's cabbages were harvested August 12–29; Red Dutch cabbages were harvested September 29; fed to cows and steers.

Each plat contained: —

	Heads.
Savoy cabbages,	31
Fottler's cabbages,	62
Red Dutch cabbages,	31

Yield of Tomatoes (Variety Essex Hybrid).

Date of Harvesting.	Plats.					
	1	2	3	4	5	6
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
August 15,	36	43¾	40	36¾	39½	16¼
August 17,	42¼	49	48¾	40¾	48	35¾
August 19,	27¾	39¼	30¾	29¾	38	14¾
August 22,	56	103	51¼	69½	109¼	21½
August 24,	29¼	49	31¾	30¼	45½	7¾
August 29,	19	23	20½	33	33½	15½
August 31,	51¾	54	36¾	63½	51½	39½
September 2,	20¾	21	21	21½	14	25½
September 5,	40¾	42	45½	42½	44½	38½
September 8,	29	30	24	21	34	21
September 10,	34½	44	39	57½	39½	26
September 16,	56	50	50	55	79	25
September 19,	21	19	28	15	18	47
Total,	464	572	466	515	593	332

Seed was obtained of Gregory & Son, Marblehead, Mass. There were two rows in each plat and twenty-two plants in

a row. The tomato plants were set out from the hot-bed May 21, came in bloom June 23 and began to form tomatoes July 7.

Yield of Potatoes (Variety Beauty of Hebron).

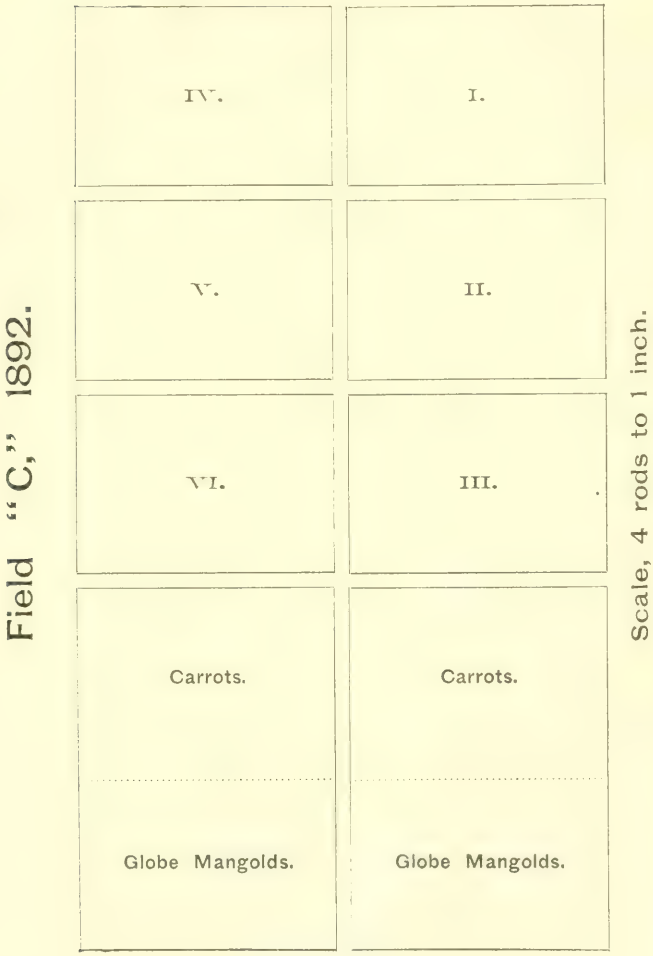
Plats.	Pounds.
Plat 1 (five rows), ...	731
Plat 2 (five rows), ...	665
Plat 3 (five rows), ...	545
Plat 4 (five rows), ...	640
Plat 5 (five rows), ...	740
Plat 6 (five rows), ...	435

The potatoes were planted May 9; were dug August 17.

Field C, Eastern Portion.

The portion of Field C east of the plats is 183 by 131 feet, and contains .55 acres. The fertilizer applied consisted of 300 pounds of fine-ground bone and 100 pounds of muriate of potash (rate of 600 pounds bone and 200 pounds muriate of potash per acre). It was spread on broadcast May 5, and harrowed in.

The western half of the piece was sown to carrots (variety Danvers) and the eastern half to globe mangolds (variety Yellow Globe) May 14, in drills two and one-half feet apart. May 30 the young plants broke ground. The globe mangolds were harvested October 17; yield, 9,635 pounds (rate of 17 tons 1,680 pounds per acre). The carrots were harvested October 31; yield, 5,545 pounds (rate of 10 tons 530 pounds per acre).


Field "C," 1892.
IV.
I.
V.
II.
VI.
III.
Carrots.
Carrots.
Globe Mangolds.
Globe Mangolds.
Scale, 4 rods to 1 inch.

4. Experiments with a Variety of New Forage Crops (1892).

Field D.

This field is 328 feet long and 70 feet wide (east to west); it covers an area of 22,960 square feet, or .527 acres. During previous years it has been used for the cultivation of a variety of annual farm and garden crops, and has been manured most of the time annually with a mixture of muriate of potash and ground bone, at the rate of two hundred pounds of the former and six hundred pounds of the latter per acre.

During the past season it has served for the raising of a variety of reputed annual and perennial fodder crops, in the majority of cases new to our section of the country, for the purpose of studying their adaptation to our climate and soil.

The field was ploughed April 19, and manured with three hundred pounds ground bone and one hundred pounds muriate of potash. It was harrowed and prepared for planting May 10. The different crops were planted in rows two and one-half feet apart, to admit of the use of a horse cultivator; all were subsequently kept clean by means of the cultivator and hoe. They were arranged in the field in the following order, beginning at the west end of the field: —

Artichoke, Jerusalem (*Helianthus tuberosus*).
Prickley comfrey (*Symphytum officinale*).
Pyrethrum (*Pyrethrum roseum*).
Forest pea (*Lathyrus sylvestris*).
Stachy's tubers (*Stachys affinis*).
Kidney vetch (*Anthyllis vulneraria*).
Winter rape (*Brassica Napus*).
Sainfoin (*Onobrychis sativa*).
Yellow trefoil (*Trifolium agrarium*).
Spring vetch (*Vicia sativa*).
Bokhara clover (*Melilotus alba*).
Summer rape (*Brassica Napus*).
Common English horse bean (*Vicia faba*).
Serradella (*Ornithopus sativus*).
Soja bean (*Soja hispida*).

Cow-pea (*Dolichos sinensis*).
Jackson wonder bean.
Blue lupine (*Lupinus cæruleus*).
White lupine (*Lupinus alba*).
Yellow lupine (*Lupinus lutens*).
Silver-hull buckwheat (*Fagopyrum esculentum*).
Japanese buckwheat (*Fagopyrum esculentum*).
Common buckwheat (*Fagopyrum esculentum*).

Artichoke, ten rows. The tubers for seed were presented by Mr. J. J. H. Gregory of Marblehead, Mass., with the request to ascertain the value of the plants as a forage crop. They were planted May 4, two feet apart in the row. The young plants appeared above the ground May 18; they began to bloom September 23, and suffered from frost October 10 (temperature 28.5° F.). The tubers were dug during the first week of November; yield, six hundred and fifty-nine pounds (rate of eight tons four hundred pounds to the acre). Some of the blooming stalks with leaves were cut and packed into suitable boxes, to ascertain their fitness for ensilage. Analyses of tubers and ensilage will be published later on.

Prickley comfrey (*Symphytum officinale*), one row. The roots used for seed were from last year's growth, in Field C. They were planted May 4. The young plants came up May 18, and bloomed June 8. The plants were cut July 8, when they were thirty inches high, and presented a rank growth of leaf and stem.

Forest pea (*Lathyrus sylvestris*), three rows. The plants used were from last year's growth, in Field C. They were transplanted May 4 and came up May 21; they reached a height of fifteen inches. The roots were remarkable in size. They were nearly two feet in length; large tubercles were quite prominent.

Stachy's tubers (*Stachys affinis*), two rows. This is the second year this plant has been raised on the station grounds. The seed tubers of last year were obtained from the United States Department of Agriculture; those of this year were from our own raising. They wintered well and were vigorous in the spring. They were planted May 4. May 18 the young plants appeared above ground. October

2 the foliage was injured by frost (temperature 33° F.). The tubers produced were scarcely one-eighth of an inch in diameter.

Kidney vetch, four rows. The seed was obtained of Henry Nungesser, New York City. One pound of seed was used, which was sown May 18. The plants came up June 1. The growth was slow, scarcely measuring three inches in the fall.

Winter rape (*Brassica Napus*), five rows. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa. This plant is used quite extensively as a green fodder in sheep-growing districts. The seed was sown May 18, and June 1 the young plants appeared above ground. The growth was heavy, reaching a height of twenty inches. August 6 the crop was cut for fodder.

Sainfoin (*Onobrychis sativa*), five rows. The seed was sown May 18. The young plants appeared above ground June 1. The growth was rather slight, measuring in the fall only ten inches. The plants failed to develop blossoms. The seed was bought of Henry Nungesser, New York City, at six cents per pound.

Yellow trefoil, five rows. The seed was sown May 18. The young plants broke ground June 1. The growth was slow, reaching a height of only three inches. The plants failed to bloom. The seed was obtained of Henry Nungesser, New York City, at eleven cents per pound.

Spring vetch (*Vicia sativa*), five rows. The seed was sown May 18. The plants came up June 1, began to blossom July 11 and to form pods August 1. The growth was cut August 5, having attained a height of twenty-seven inches. The seed was obtained of J. M. Thorburn, New York City, at four and one-half cents per pound. This valuable fodder plant has served us for several years as green fodder in connection with oats.

Bokhara clover (*Melilotus alba*), five rows. The seed was sown May 18. The plants appeared above ground June 1. The leaf development was rather light. October 7 the plants were cut, having reached a height of twenty-eight inches. The seed was obtained of H. Nungesser, New York City, at twenty cents per pound.

Summer rape (*Brassica Napus*), five rows. The seed was sown May 18. The plants appeared above ground June 1. The character of the growth was very much the same as that of winter rape, described above. Four rows were cut for fodder August 6; the remaining row was left to develop farther, but was finally cut, the plants failing to blossom. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa.

Common English horse bean (*Vicia Faba*), five rows. The seed was sown May 18. The plants broke ground June 1, bloomed July 5 and began to develop pods August 6. The growth was characterized by large, coarse stalks and small leaf development. Height of plants September 7 was forty-two inches. The seed was obtained of J. M. Thorburn, New York City, at nine cents per pound.

Serradella (*Ornithopus sativus*), five rows. The seed was sown May 18. The young plants appeared above ground June 1 and came in bloom July 21. The growth was heavy and of good quality. This crop furnishes an excellent green fodder. We have raised it this year at the rate of twelve tons to the acre. A silo has been filled with a mixture of serradella and Hungarian grass (3 : 1), which will be reported upon in the future. The serradella seed was obtained of H. Nungesser, New York City, at eight cents per pound.

Soja bean (*Soja hispida*), five rows. The seed was sown May 18. The young plants appeared above ground June 1 and began to bloom September 22. The growth was very good, reaching a height of about three feet, but was very light colored. October 2 the foliage was injured by frost (temperature, 33° F.). The seed was bought of J. M. Thorburn, New York City, at eight cents per pound.

Cow-pea (*Dolichos sinensis*), five and one-half rows. The seed was sown May 18. The plants broke ground June 1, came in bloom August 23 and began to form pods September 22. The plants were injured by frost October 2 (temperature, 33° F.). The seed was obtained of D. Landreth & Sons, Philadelphia, Pa.

Jackson wonder bean, one-half row. The seed was sent on for trial by the M. W. Johnson Seed Company, Atlanta, Ga. It was sown May 18. The young plants appeared

above ground June 1, blossomed during the middle of July and began to form pods August 6. The growth resembled very much the common pole bean.

Blue lupine (*Lupinus cœruleus*), five rows. The seed was sown May 18. The young plants appeared above ground June 1, blossomed July 19 and began to develop pods July 27. The growth was heavy, reaching a height of thirty-eight inches July 25. August 30 the plants were cut for seed. The lupines are considered an excellent crop for green manuring. The seed was bought of J. M. Thorburn, New York City, at fifteen cents per pound.

White lupine (*Lupinus alba*), three rows. The seed was sown May 18 and came up June 1. July 7 the plants began to bloom, and August 1 pods were forming. The growth attained a height of thirty-three inches, being somewhat lighter than that of the blue lupine. August 22 the plants were cut for seed. The seed was bought of J. M. Thorburn, New York City, at eleven cents per pound.

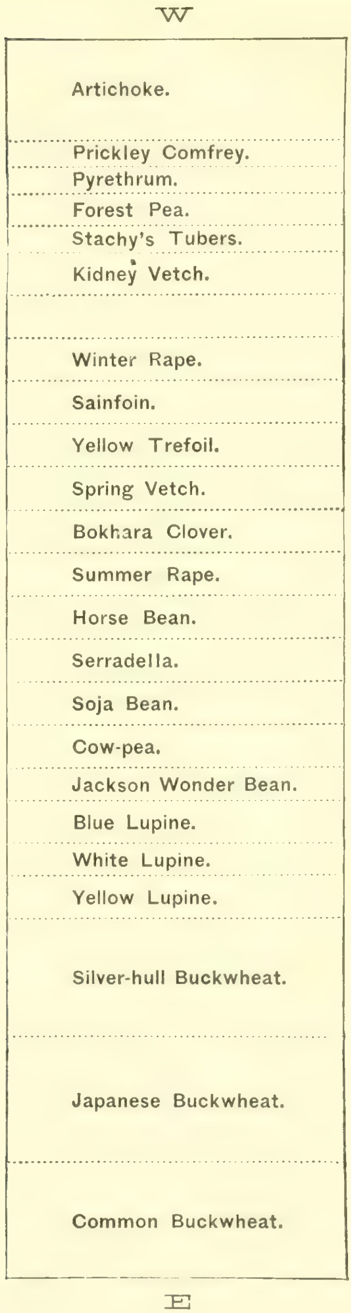
Yellow lupine (*Lupinus lutens*), five rows. The seed was sown May 18. The plants broke ground June 1, came in bloom July 21 and began to form pods August 1. This lupine shows the lightest growth of the three, reaching a height of twenty-four inches. Seed was bought of H. Nungesser, New York City, at seven cents per pound.

Silver-hull buckwheat, twelve rows. Seed was sown May 18, came up May 28. The plants made a rapid and heavy growth, measuring, July 7, thirty-four inches. They began to bloom June 25 and were cut for fodder July 11. The seed was obtained of J. M. Thorburn, New York City, at six and one-fourth cents per pound.

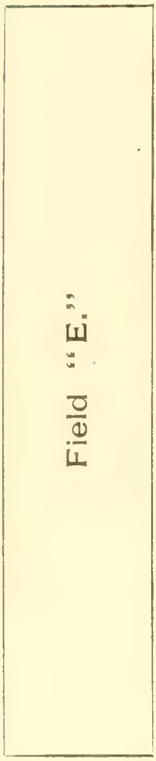
Japanese buckwheat, twelve rows. The seed was sown May 18, came up May 28. The plants began to bloom June 30 and were cut for fodder July 11; average height, thirty inches. Seed was obtained of J. M. Thorburn, at six and one-fourth cents per pound.

Common buckwheat (*Fagopyrum esculentum*), eleven rows. The seed was sown May 18. The young plants appeared above ground May 28, began to bloom June 23 and were cut for fodder July 11; average height, thirty-six inches. The seed was bought of J. M. Thorburn, at six and one-fourth cents per pound.

Field "D," 1892.



Scale, 50 feet to 1 inch.



Scale, 4 rods to 1 inch.

Field E (Potatoes).

This field is 260 feet long and 48 feet wide; it contains .286 acres. The field was ploughed April 20. The following fertilizer was applied April 27: 250 pounds fine-ground bone, 75 pounds sulphate of potash, high grade, ninety-five per cent. (rate of 600 pounds bone, 200 pounds sulphate of potash, high grade, per acre approximately).

At the northern part of the field were a few rows of violets under the care of Professor Humphrey. The remainder of the field (.26 acres) was planted to potatoes (variety Beauty of Hebron), April 30, in rows two and one-half feet apart. Seven bushels of seed were used. On account of the cold weather the potato plants did not appear above ground until May 28. August 4 the potato tops began to die, and August 15 the tubers were dug. They were more or less scabby and rather poor in quality; total yield 2,775 pounds (10,673 pounds, or 212 bushels, to the acre).

5. Field Experiments with Different Commercial Phosphates to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates.

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each twenty-one feet wide, with a space of eight feet between adjoining plats.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article; namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	0.00	–	0.00	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9.04	6.26

In 1890 potatoes were raised on the plats; in 1891 winter wheat was the crop experimented with (for details see ninth annual report). The following fertilizing mixtures have been applied annually to all plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 290 pounds to the acre, and potash-magnesia sulphate at the rate of 390 pounds per acre.

1892. — The field was sown to serradella May 17, in drills two and one-half feet apart; thirty-two pounds of seed were used for the entire piece. The seed was bought of Henry Nungesser, New York City, at eight cents per pound. May 28 the young plants appeared above ground and were quite uniform in all the plats. July 20 the serradella came in bloom, the average height being five inches. The growth was slow at first, but during the hot days of August it made rapid strides, and at the time of cutting (September 9, 10) the plants measured on an average thirty-one inches in length, and covered the ground with a complete mat of foliage. The serradella was cut, at the time stated above, while perfectly green, and packed in a silo with Hungarian grass. Following is a statement of the yield of the several plats: —

Plats.	Weight of Green Serradella (Moisture, 82.03 Per Cent.).	Yield per Acre.
	Pounds.	Tons.
Plat 1,	4,070	13.69
Plat 2,	3,410	11.29
Plat 3,	2,750	9.05
Plat 4,	3,110	10.10
Plat 5,	2,920	9.36

Analysis of Serradella (Green).

[Station, Field F, 1892.]

	Per Cent.
Moisture at 100° C.,	82.03
Dry matter,	17.97
	100.00

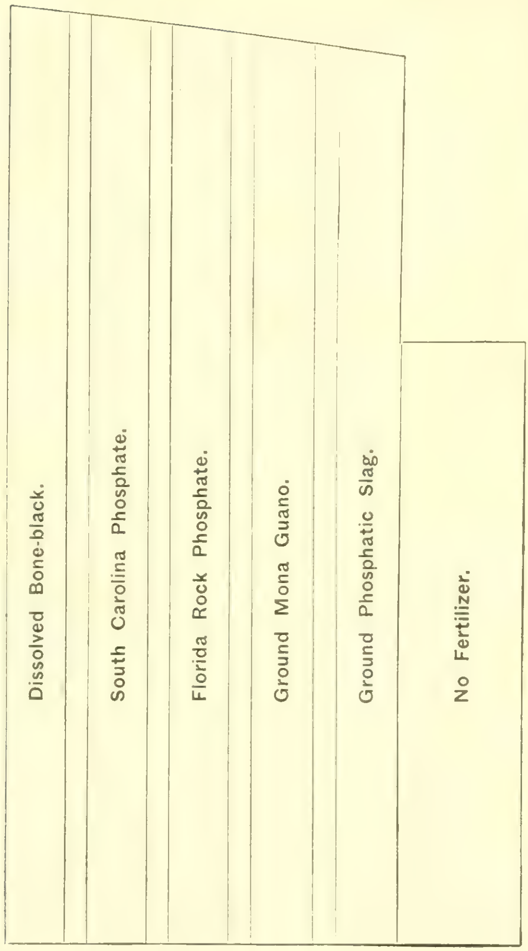
Analysis of Dry Matter.

	Per Cent.
Crude ash,	9.59
" cellulose,	26.28
" fat,	2.59
" protein,	15.13
Non-nitrogenous extract matter,	46.41
	100.00

Fertilizing Constituents.

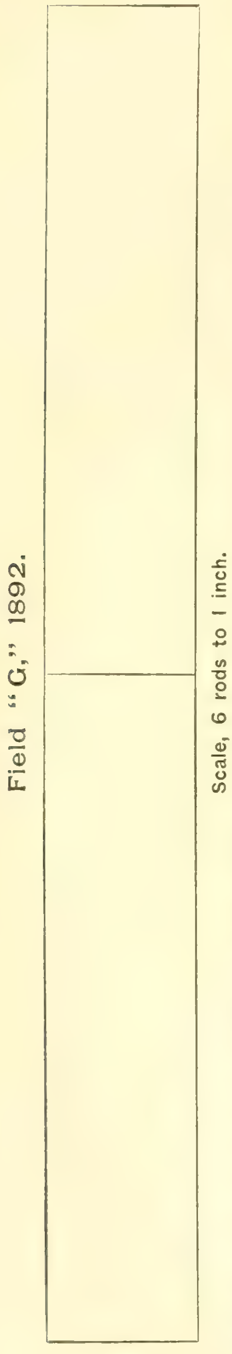
Moisture,	82.03
Nitrogen,	0.435
Phosphoric acid,	0.126
Potassium oxide,	0.379
Valuation per 2,000 pounds,	$1 78

Field "F," 1892.



Serradella.

Scale, 4 rods to 1 inch.



6. Experiment with Vetch and Oats for Green Fodder and Hay (1892).

Field G.

This field is 700 feet long and 75 feet wide; area, 52,500 square feet, or $1\frac{1}{5}$ acres. The land is nearly level and the soil a loam several feet in depth. No manurial matter has been applied since 1890, the object being to reduce the stored-up plant food, and thereby prepare the soil for future field experiments with special fertilizers.

The field was ploughed April 18, and subsequently thoroughly harrowed. The northern half of the field was sown to vetch and oats April 21. Two bushels of oats and thirty-five pounds of spring vetch were used for seed. The southern half of the field was sown June 1, four bushels of oats and thirty-five pounds of spring vetch being used for seed. The plants came up May 3 on the northern half and June 6 on the southern half of the field.

We commenced cutting the crop for green fodder June 28, when the vetch was beginning to bloom and the oats to head out, beginning at the north end. The portion of the northern half cut over in this manner was 109 by 75 feet, or 8,175 square feet. The yield was 3,020 pounds (rate of 8 tons to the acre). The remainder of this half was cut and dried for hay. Yield of well-dried hay, 1,195 pounds (rate of 2,900 pounds to acre). The cutting of the southern half of the field was commenced July 12. The total yield of green fodder amounted to 3 tons 1,148 pounds (rate of 5 tons 1,900 pounds to the acre).

The analysis of vetch and oats will be found below: —

Vetch and Oats (Green).

	Per Cent.
Moisture at 100° C.,	82.02
Dry matter,	17.98
	100.00

Analysis of Dry Matter.

Crude ash,	9.31
" cellulose,	29.80
" fat,	2.79
" protein,	16.77
Non-nitrogenous extract matter,	41.33
	100.00

Fertilizing Constituents.

Moisture,	82.02
Nitrogen,	0.482
Phosphoric acid,	0.132
Potassium oxide,	0.418
Valuation per 2,000 pounds,	$1 97

Canada Peas and Oats.

[Young orchard, east fields.]

The area occupied by this crop was one acre approximately. The seed was sown broadcast April 29, 1892, two bushels of Canada peas and four bushels of oats being used. The peas were slightly ploughed in and the oats harrowed in. The young plants appeared above ground May 6, and made a rapid and luxuriant growth. Began to cut the crop for green fodder June 13, when the peas were coming in bloom. The plants attained a height of nearly three feet, and yielded five and one-half tons per acre of green fodder of the following composition: —

Analysis of Canada Peas and Oats (Green).

[Station, 1892.]

	Per Cent.
Moisture at 100° C.,	86.32
Dry matter,	13.68
	100.00

Analysis of Dry Matter.

Crude ash,	6.90
" cellulose,	26.66
" fat,	2.29
" protein,	16.01
Non-nitrogenous extract matter,	48.14
	100.00

7. Experiments with Grass Land (Meadows).

The permanent grass lands are by their location arranged into two divisions, west and east of a public highway. They cover at present a space of sixteen to seventeen acres.

The *west side division* consists of old meadows, kept for over twenty years in grass. The area has for years been steadily reduced in size by turning, as circumstances advised, more or less at a time into plats for field experiments. In their present condition they surround our main field for experimental purposes. They are in part underdrained, and are kept, by a moderate annual top-dressing with barnyard manure, in a fair state of production, considering the condition of the sod. The area comprises to-day approximately not more than seven acres.

The *east side division* of meadows comprises an area of about 9.6 acres. The entire field to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion, and covered with weeds and sedges in its lower section. The improvement of the land by underdraining and ploughing, and subsequently by the use of a system of drill culture, began in some parts (north end) in 1886 and in others (south end) in 1887. For the details of this work see ninth annual report (1891). The following seeds have been applied : —

In 1888, to the more elevated portions —

Two bushels herds grass (*Phleum pratense*).
Two bushels red top (*Agrostis vulgaris*).
Two bushels Kentucky blue-grass (*Poa pratensis*).
Two bushels meadow fescue (*Festuca pratensis*).
Seven pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

This was applied at the rate of from two to two and one-half bushels per acre. The lower and more wet portion of the meadow was seeded down with the following mixture of grass seeds : —

Twenty pounds soft brome grass (*Bromus mollis*).
Twelve pounds herds grass (*Phleum pratense*).
Nine pounds red fescue (*Festuca rubra*).
Eight pounds fowl meadow grass (*Poa serotina*).
Seven pounds Rhode Island bent (*Agrostis alba*).
Six pounds orchard grass (*Dactylis glomerata*).
Five pounds crested dog-tail (*Cynosurus cristatus*).
Four pounds meadow soft grass (*Holcus lanatus*).
Two pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

In 1889, from four to five pounds of alsike clover per acre were added by broadcast seeding to the meadow early in the spring.

In 1890, from two to three pounds of alsike clover seed were sown per acre on the entire meadow.

In 1892 the entire area was divided into four plats, numbered I., II., III., IV., beginning at the north end. The following system of manuring was adopted: —

Plat I. (1.95 acres), 31,200 pounds barn-yard manure, applied late in the fall of 1891 (rate of 8 tons to the acre).

Plat II. (2.02 acres), 24,240 pounds barn-yard manure, applied March 4, 1892 (rate of 6 tons to the acre).

Plate III. (2.59 acres), 1,554 pounds ground bone, 518 pounds muriate of potash, applied April 18, 1892 (rate of 600 pounds bone and 200 pounds muriate of potash per acre).

Plat IV. (3 acres), 3 tons unleached wood ashes, applied April 15, 1892 (rate of 1 ton to the acre).

Following is the yield of hay (first and second cut) for three consecutive years: —

Yield of Hay in 1890.

Plat I.	First Cut.	Second Cut.
1.92 acres, . .	14,625 pounds, July 1.	3,790 pounds, Sept. 1.

Total yield of hay, 18,415 pounds.
Yield per acre, 9,591 pounds, or 4.80 tons.

Yield of Hay in 1890 — Concluded.

PLAT II.	First Cut.	Second Cut.
1.92 acres, . .	12,480 pounds, July 1.	3,105 pounds, Sept. 3.

Total yield of hay, 15,585 pounds.
Yield per acre, 8,117 pounds, or 4.06 tons.

PLAT III.	First Cut.	Second Cut.
2.41 acres, . .	14,460 pounds, June 26.	3,535 pounds, September.

Total yield of hay, 17,995 pounds.
Yield per acre, 7,466 pounds, or 3.73 tons.

PLAT IV. (IV. and V., **1889.**)	First Cut.	Second Cut.
3 acres, . . .	13,380 pounds, July 1.	4,080 pounds, Sept. 3.

Total yield of hay, 17,460 pounds.
Yield per acre, 5,820 pounds, or 2.91 tons.

Yield of Hay in 1891.

PLATS.	First Cut.	Second Cut.	Total.
	Pounds.	Pounds.	Pounds.
Plat I., per acre, ...	6,528	1,446	7,974
Plat II., per acre, ...	5,988	1,440	7,428
Plat III., per acre, ...	4,641	1,015	5,656
Plat IV., per acre, ...	3,750	1,610	5,360

Yield of Hay in 1891 — Concluded.

Plats.	Total Yield.		Total Yield per Acre.	
	Tons.	Pounds.	Tons.	Pounds.
Plat I.,	7	1,549	3	1,974
Plat II.,	7	1,004	3	1,428
Plat III.,	7	649	2	1,656
Plat IV.,	8	80	2	1,360

Yield of Hay in 1892.

Plats.	First Cut.				Second Cut.			
	Total Weight.		Rate per Acre.		Total Weight.		Rate per Acre.	
	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.	Tons.	Pounds.
Plat I.,	5	805	2	1,541	2	45	1	74
Plat II,	5	895	2	1,394	1	1,975	–	1,968
Plat III.,	6	50	2	652	1	1,320	–	1,282
Plat IV.,	6	1,087	2	362	3	110	1	36

Plats.	Total Yield.		Total Yield per Acre.	
	Tons.	Pounds.	Tons.	Pounds.
Plat I.,	7	850	3	1,615
Plat II.,	7	870	3	1,362
Plat III.,	7	1,370	2	1,934
Plat IV.,	9	1,197	3	398

Yield of Hay on West Side Division.

	Tons.	Pounds.
First cut,	9	510
Second cut,	3	25

Following is the analysis of hay and rowen grown on the plats: —

[I., hay; II., rowen.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	8.94	11.31
Dry matter,	91.06	88.69
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	6.64	6.48
" cellulose,	34.82	29.98
" fat,	3.18	4.23
" protein,	10.41	12.11
Non-nitrogenous extract matter,	44.95	47.20
	100.00	100.00

Fertilizing Constituents.

	I.	II.
Moisture,	8.94	11.31
Nitrogen,	1.516	1.717
Phosphoric acid,	0.269*	0.432*
Potassium oxide,	1.55*	1.486*
Valuation per 2,000 pounds,	$6 24	$6 96

* Average in ninth report.

8. Report on General Farm Work (1892).

The lands assigned for the use of the Massachusetts State Agricultural Experiment Station cover an area of fifty acres. Ten acres are natural woodlands, and forty acres, including the space occupied by the buildings, are used for the raising of farm crops. At present from fifteen to sixteen acres are under cultivation, and from sixteen to seventeen acres are permanent grass lands. As every portion of the land is at present serving for some special experiment, the general management of the farm is to a controlling degree subjected to the requirements of the work called for in connection with the various questions under investigation. The adoption of a thorough mechanical preparation of the soil, supported by a careful, clean cultivation of the crops raised, has brought the lands into a fair condition for field experiments. Each field has had for years its own system of manuring, and becomes thereby from year to year more valuable for experimental purposes. Wherever circumstances have been favorable, forage crops have been chosen, for the purpose of studying the influence of various systems of fertilization and cultivation on their growth and special character. This practice has resulted already in the successful introduction of some valuable forage plants new to our locality, and has also materially assisted us in an economical support of quite extensive experiments in stock feeding. The beneficial effect of many of these crops on the physical and chemical condition of our cultivated lands is everywhere noticed, when compared with their previous general condition.

During the past season several varieties of soja bean, serradella, Canada peas and oats, summer vetch and oats have been raised, to supplement our current farm crops, as corn, rye, barley, Hungarian grass, etc., for feeding purposes.

Three silos have been filled with mixtures of different crops; one silo is filled with equal weights of fodder corn and soja bean, one with two parts soja bean and one part fodder corn, and the third with three parts serradella and one part Hungarian grass.

The character and amount of farm and garden crops raised in 1892 may be seen from the subsequent statement: —

	Tons.
Hay (first cut),	35
Rowen (second cut),	$11\frac{3}{4}$
Fodder corn (green),	$17\frac{1}{2}$
Corn stover,	$4\frac{3}{4}$
Corn (ears),	$\frac{3}{4}$
Roots (beets, $1\frac{1}{3}$; mangolds, $4\frac{3}{4}$; carrots, $2\frac{3}{4}$; turnips, $\frac{1}{4}$),	9
Rye (643 pounds grain, 1,767 pounds straw),	$1\frac{1}{5}$
Barley (539 pounds grain, 1,289 pounds straw),	$\frac{9}{10}$
Oats (318 pounds grain, 1,227 pounds straw),	$\frac{3}{4}$
Potatoes,	$3\frac{1}{5}$
Tomatoes,	$1\frac{1}{2}$
Cabbages,	3
Vetch and oats (green),	5
Vetch and oats (dry),	$\frac{1}{2}$
Soja bean (green),	10
Soja bean (straw, 770 pounds; beans, 240 pounds),	$\frac{1}{2}$
Canada peas and oats (green),	$1\frac{3}{4}$
Canada peas and oats (dry),	$\frac{3}{4}$
Miscellaneous crops,	$2\frac{1}{2}$

9. Department of Vegetable Physiology.

Report by Dr. James Ellis Humphrey.

As in previous years, the work of the department has steadily continued since the last report. The results of the year's investigations to be described in the following pages contain several matters of scientific interest and of practical importance to various classes of cultivators. The work on diseases of some leading winter crops has been continued, and a considerable part of the present report is occupied by a discussion of the known fungous diseases of the cucumber plant, both under glass and in the open air. Studies of a disease of English violets are described; as also some cultures of the "black-knot" fungus of the plum, with suggestions for its practical control. Directions for avoiding the attacks of the fungi known as powdery mildews will also be found, and briefer notes on other disease-producing fungi of importance.

The department has replied, during the year, to numerous inquiries from various sources touching a wide range of subjects, and has been able to be of considerable service to the farmers and gardeners of the State in this way.

In closing his connection with the station with the completion of this report, the writer desires to express the hope that the value of mycological investigations has been sufficiently demonstrated to ensure their continuation at Amherst.

The subject-matter of the present report is arranged under the following heads: —

I. Diseases of the cucumber plant.
   1. Sclerotium disease ("timber rot").
   2. Powdery mildew.
   3. Downy mildew.
   4. Damping off.
   5. Leaf blight.
   6. Leaf glaze.
   7. Other diseases.

II. A violet disease.
III. The black knot of plum and cherry.
IV. Grain rusts.
V. Various diseases.
  1. Powdery mildew of strawberry.
  2. Powdery mildew of gooseberry.
  3. Cluster cup of gooseberry.
  4. A hazel fungus.
VI. Treatment for powdery mildews.

As before, the "General Account of the Fungi," on pages 195 to 211 of the seventh report of this station, may be found useful as an aid to the full understanding of the following discussions.

I. Diseases of the Cucumber Plant.

1. A Sclerotium Disease. — *Sclerotinia Libertiana* F'k'l (Plates I. and II.)

A subject concerning which many and urgent inquiries have been addressed to the writer by growers of winter cucumbers near Boston is the disease known among them as "timber rot." * This trouble makes its appearance regularly in the spring, when the plants are well grown and in bearing, and is a cause of much loss. The first specimens showing the nature and effects of the disease were received in May last, from W. W. Rawson, Esq., of Arlington; and subsequently a visit was made to his greenhouses, where the disease was seen in various stages of development, and further specimens for study were obtained.

The most cursory examination of good specimens makes it evident that we have here to do with a fungous disease of much interest. It attacks chiefly the stems of the host-plants, sometimes the fruits. I am not aware that it ever attacks this crop out of doors, but in the warm and moist atmosphere of the cucumber house the fungus finds very

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* Concerning the origin of this name it is not easy to suggest an explanation. Popular names of diseases serious enough to attract attention are usually in some way descriptive or otherwise appropriate. The present name has little of such quality to recommend it, and I have no clue to its origin, unless the appearance of the fresh mycelial threads on the stem may have suggested that of the mycelium of *Merulius lachrymans* and other hymenomycetous species which attack wood.

congenial conditions for luxuriant development. The earliest external sign of the presence of the fungus to which the disease is due is commonly the appearance of dense white mats of its mycelium at and near the nodes of the stem (Pl. I., *a*). Examination shows that the tissues of the stem are thoroughly permeated by the fungus-threads, which have here burst through the surface. At this stage the stem is still green and plump (Pl. I., *a*), but as the disease progresses it begins to shrink (Pl. I., *b*) and to turn yellow. Later, its cellular tissue (parenchyma) undergoes what may be termed a sort of granular decay, shrivels, and finally dries up, leaving hardly more than a withered mummy of the original stem, consisting of the dried and yellow vascular bundles and epidermis (Pl. I., *c*).

In the interior of diseased stems may be found thick masses of white mycelium, and in the later stages there appear, especially near the nodes, hard, slender black bodies, sometimes of considerable size, which remain after the disappearance of the mycelium (Pl. II., fig. 1). These serve as a clue to the cause of the disease when only the dried skeleton of the stem remains. Sometimes similar black bodies are developed in the mycelial mats on the exterior of the stems (Pl. I., *d*), but this is not commonly the case. Where it does occur, these bodies, instead of being slender and spindle-shaped, are usually rounded or irregular in outline, and more or less flattened. In either form they are at once recognizable as the characteristic resting stage of certain fungi, known as *sclerotia*, and point strongly to the probability that the disease is due to one of the parasitic cup-fungi (*Discomycetes*) of the genus *Sclerotinia*. The young fruits are often attacked by the fungus, becoming soft and watery, and their surfaces being covered by the white mycelium. The rounded and flattened sclerotia are usually quite freely developed on the rotted fruits (Pl. I., *fr.*), and are often found adhering to their shrunken remnants. Sometimes two or more sclerotia of the surface form arise so close together as to become united into an irregular mass (fig. 2).

These sclerotia arise from masses of fungus-threads which

become closely intertwined, branching and increasing in size until a compact structure is formed. This is at first white, but its outer layers soon become changed, and their cell walls thickened and blackened to form a protective rind about the inner unchanged parts. A section through the inner portion of a mature sclerotium shows that the constituent threads have become so closely compacted that they form a firm pseudoparenchyma (fig. 6). As they lie in all directions, any section is sure to follow the course of some of the threads, while others are cut at all angles. Thus the apparent cells of the pseudoparenchyma vary in outline from circular to much elongated. The cell cavities have abundant protoplasmic contents, but neither starch nor oil can be recognized in them. When sections are submitted to Errera's iodine test, however, they prove to be very rich in glycogen, which doubtless serves as a reserve food material for the future development of the sclerotia. These bodies are to be regarded, then, as resting mycelia, which serve the same purpose as the resting spores of some fungi in tiding over periods unfavorable to active development, and thus keeping alive the species from season to season.

In order to learn the history of their further development, a number of sclerotia were placed in moist chambers May 26, a part on rather poor soil and a part on pure quartz sand. Both lots were kept about equally damp, and stood side by side in a north window; but those on the sand began their "germination" more promptly and carried it through more satisfactorily. As those on the soil gave no results different from the others, and were subsequently transferred to sand, where they did much better, they will be neglected in the following account. But it should be said that this result was to be expected under the very artificial conditions of the culture chamber, and cannot be held to be equally applicable to the greenhouse. In a month one of the sclerotia on quartz sand showed signs of further development. Two slender stalks were growing upward from its upper side, and two others were just breaking through its lower surface. This would indicate that the points of origin of these stalks are not determined by the amount of light to which they are

exposed. The rate of growth of the stalks may be indicated by the fact that two which were five millimeters long June 28 (fig. 3) had become nine millimeters long July 8, ten days later. Two months after the beginning of the culture several sclerotia showed from one to four stalks each, some of them well developed. These stalks are bundles of nearly parallel threads, arising from the inner tissue of the sclerotium and bursting through the rind. They are at first white, except for a short distance above their bases, and their sides are clothed by the short and delicate free ends of some of the outer threads. If they assume an erect position from the first, their basal portions are only slightly dark colored (figs. 3 and 7); but if, as often happens, they grow for a time beneath the surface of the sand or soil, these portions may have hardened and blackened surfaces (fig. 5). These stalks, or their aerial portions, are very sensitive to light. In cultures before a window the young stalks grew from the first strongly toward the window. When the culture chamber was turned through 180°, so as to make them point away from the window, they very promptly responded to the stimulus of the light, and in a single day showed strong heliotropic curvature. In two or at most three days they had bent sharply upon themselves, and were again directing their tips obliquely toward the light, in response to the combined influences of negative geotropism and positive heliotropism. By the time a stalk reaches a length of about five millimeters above the surface of the sclerotium or of the soil, a conical depression begins to appear in its upper end (fig. 7). This depression arises and increases in size by greater growth at the circumference than at the centre of the stalk, and the final result is a shallow cup crowning the stalk. Some idea of the rate of growth of these cups may be gained by comparing the stages *a* and *b* in figs. 4 and 5, in each of which the condition shown at *b* represents the gain in four days over *a*. Under favorable conditions the cups may reach a diameter of as much as eight millimeters, and they have been been even larger. Ordinarily, when they become larger they are also much flattened, having often the form of disks, with only slight depressions at their centres. When mature,

their outer surfaces remain of a white or slightly creamy color, while their inner or upper faces are of a brownish or clay-colored shade.

While still very young the cups may be seen to be the spore-producing organs of the fungus. The body of a cup is composed of threads, which are continuations of and similar to those of the stalk; but its inner surface is composed of two kinds of threads, arising from the vegetative threads of the outer portion and standing close together parallel to each other and at right angles to the surface, like the threads of the "pile" of velvet. A part of these threads are essentially similar to those from which they arise, and these terminate in blunt ends. They are known as *paraphyses*. The rest are much swollen, and when young have dense protoplasmic contents. As they reach their full size the contents begin to show differentiation, and there finally appear in each of these spore-sacs eight colorless, elliptical spores (fig. 8). When the spores are quite mature, one may observe that the tip of the spore-sac (*ascus*) appears thickened and gelatinous. It is through this apical part of the wall that the spores are discharged; and after their escape one may see the opening through which they have passed out. The ejection of the spores from an ascus takes place suddenly and explosively, and, as the tips of the asci form the inner surface of the cup, they pass directly into the air. If a cup be allowed to develop quite undisturbed in a moist chamber for two or three days, and then be slightly jarred, the escape of the spores from the numerous asci that have ripened during the interval can be plainly seen, like a tiny puff of white smoke from the surface of the cup. If a glass slip, moistened with water, be held over the cup when this occurs, the spores (fig. 8, *sp.*) can be obtained very pure and in considerable quantity. As has been said, the asci and spores begin to mature when the cup is still very small, and the ripening of successive ones continues during and after the close of the growth of the cup, for a period of three weeks or more. During this time the number of spores produced by a single cup is enormous, and quite beyond approximate estimations. In my cultures

of a few sclerotia produced on a single young fruit (Pl. I., *fr.*), they continued to give rise to successive new cups for a period of four months.

A comparison of the structures which have been described with the recorded facts concerning the known *Sclerotiniæ* shows that in the form and structure of the sclerotia, in the color, form and size of the cups, and in the form and size of the spores, this fungus fully agrees with the European species known as *Sclerotinia Libertiana* F'k'l., and described by Brefeld * and DeBary † under the name *Peziza Sclerotiorum*. Our first cultures with this fungus were made immediately after obtaining the material, with the only parts of the plant then available, mycelium taken from diseased cucumber stems, and sclerotia. On prune-gelatine a small bit from a mass of mycelium gave rise to abundant threads, ramifying through the substratum, and producing abundantly the "attachment organs," to be described later, but giving rise neither to sclerotia nor to any spore form. Thin slices from the inner tissue of sclerotia sown on the same substratum gave the same result. But when similar slices were sown on sterilized bread, saturated with an infusion of prunes, the bread became completely enveloped in a white mycelial cloud. A week after the beginning of the culture the mycelium had collapsed into a thick film over the surface of the bread, and a few rather small sclerotia had formed on the surface. Two weeks later, no further change having been observable and all development having evidently ceased some time before, the whole was removed from the moist chamber, and it was found that beneath the superficial mycelial film, and occupying the space originally occupied by the substance of the bread, was an almost solid mass of well-matured sclerotia, varying in size from that of small shot to that of a large pea.

We may consider next the cultures with ascospores made after the development of the spore cups from the sclerotia afforded the means of obtaining them. When these spores are sown in distilled water and protected from drying up, they germinate promptly and show considerable growth by

* Botanische Untersuchungen über Schimmelpilze, IV.: 1881.

† Botanische Zeitung, 1886, Nos. 22–27.

the end of the first day (fig. 9). They may continue to grow for about two days, in which time the germ tube may become several times as long as the greater diameter of the spore. If no nourishment be obtainable, growth ceases and death follows. If, however, nourishment be provided in the form of an infusion of prunes, for instance, the development of the germ thread is very rapid, and the entire culture drop is filled by a mat of strong and branching threads. The difference in development due to absence or presence of nourishment may be seen by comparing figs. 9 and 10, which represent spores after one day's development under these opposite conditions, respectively. Vigorous branches of the mycelium grow upward into the air and downward into contact with the glass slip supporting the culture. No traces of spore formation could ever be detected on the aerial threads, although carefully sought for. On the branches which come in contact with the glass are produced in all nourished cultures, and very abundantly, certain structures characteristic of this and related species of fungi, and known as *attachment organs*. These organs appear to be formed whenever branches of a growing mycelium come in contact with firm unyielding objects. They are produced by the rapid and more or less exactly dichotomous branching of a thread, which, at the same time, becomes much stouter and richer in protoplasmic contents than before. The short and densely aggregated branches form a thick tassel, which becomes attached by the free ends of its branches to the substratum (fig. 11). At this time these organs are readily recognized by the naked eye as small darker spots on the glass of the culture slip or vessel. A day after its complete development one of these organs shows signs of degeneration. Its dense contents begin to become watery and to disappear, and by the second day there is left little but the empty outer walls, enclosing a nearly or quite continuous cavity (fig. 12). The possible or probable significance of these peculiar structures may be discussed later. Slide cultures of spores in prune infusion or similar fluid medium rarely yielded anything besides mycelium and attachment organs; but occasionally a small sclerotium is developed. The vegetative development on

any nutrient substratum is accompanied by a remarkable formation of the octahedral crystals of oxalate of lime, which are produced in immense numbers in the interstices between the threads.

Ascospores sown on sterilized bread saturated with an infusion of prunes, in test tubes, produced an abundant and beautiful mycelium over the whole surface of the bread and far above it. The branches in many places reached the inner surface of the tubes, and there developed great numbers of attachment organs. No spore formation ever occurred; but a week after the beginning of the culture dense white masses were detected among the looser threads. On examination these proved to be very firm lumps of matted threads; and the following day they had become nearly black in color. A day later, nine days from the sowing of the spores, the cultures contained many larger and structurally mature sclerotia. In this case the sclerotia were produced wholly upon the surface, and did not replace at all the substance of the bread, as in a previously described instance. Subsequent examination showed that no further development occurred, the activity of the mycelium ceasing with the formation of the sclerotia.

If ascospores be sown in water on the surface of a cucumber stem, or at its growing point, it might be expected that the germ tubes would promptly penetrate the tissues and infect the plant, if it be really true that this fungus is the efficient cause of the disease. But, although carefully protected from drying, they utterly fail to attack the plant, even though sown in a fresh cut reaching to the active tissues of the plant, when sown in water only. On the other hand, if they be sown on a healthy and uninjured part of the plant, in a drop of nutrient fluid, the result is very different. Germination proceeds rapidly, attachment organs are formed on the surface of the plant, and soon this surface is penetrated by fungus-threads which quickly spread through the tissues. In this way infection takes place, and the plant is lost. Even the leaves of a plant kept in a moist chamber are in this way readily attacked. Three days from the sowing of a small drop of prune infusion containing fresh ascospores upon a large leaf of such a plant, the leaf was a

slimy mass of decay, while a neighboring one, sown with spores in pure water at the same time, remained perfectly sound. Two days later the whole plant had succumbed. If a bit of decayed tissue, containing abundant and vigorous threads of the fungus, be placed upon a healthy plant, the latter is promptly attacked and destroyed. These results furnish interesting confirmation of DeBary's conclusion* that the spores of this fungus are unable to attack its host-plants parasitically until their germ tubes have been saprophytically nourished for a time. That is, the fungus may be said to be in process of acquiring a truly parasitic habit which it has not yet fully developed. There is no reason to doubt that these spores, germinating on the rich soil of the greenhouse, about the bases of the plants, find there all the nourishment needed for the development of a mycelium capable of parasitic invasion. It seems very probable, too, that DeBary's explanation* of the significance and function of the so-called attachment organs is the correct one. This is to the effect that these organs, developed on the firm surface of the host from the saprophytically nourished mycelium, produce in the fluid which results from the breaking down of their protoplasm, previously described, some substance which softens the cell walls and kills the cell contents of the host. The fungus-threads are then able to attack these dead cells, and thence to penetrate farther and farther into the tissues of the host-plant. After its establishment, and the development of an abundant mycelium within the host, the fungus forms its sclerotia just as in the cultures above described, their form being somewhat modified by the shape of the cavity when they develop in the inner spaces of the plant.

We pass now to consider the question of other spore forms of this fungus. It is a well-known fact that many Ascomycetous fungi possess one or more secondary "summer spore" forms, known as conidia, pycnidia, etc.; and some such forms have been found to belong to those species of fungi most closely related to the present one. None has, however, been heretofore proved to belong to the present species. Therefore, when, in examining plants in Mr. Raw-

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* Botanische Zeitung, 1886, Nos. 22–27.

son's greenhouse, a young rotting cucumber was found which bore, besides the white *Sclerotinia* mycelium, the dark spore threads and abundant spores of a *Botrytis* form, the question of its genetic connection with the *Sclerotinia* became a very interesting one. The specimen was carefully preserved, and the spores were obtained quite pure for a series of cultures. When sown on prune-gelatine they produced a luxuriant mycelium, whose growth was accompanied by a characteristic formation of crystals of oxalate of lime. From this mycelium were developed numerous attachment organs, like those above described, and spore threads, with spores, identical with the original *Botrytis* form. Except for its physiological similarity in the production of oxalate of lime and the structural similarity of its attachment organs, there was no ground for suspecting any connection between this form and the *Sclerotinia*. Sown on bread saturated with prune infusion, the original spores gave results precisely similar to those above described. When sown on a solid block of sterilized potato in a test tube, however, they produced not only abundant attachment organs and spore threads, but also sclerotia. Nine days after the beginning of a culture, very dense masses of mycelium were seen at the angles of the block of potato, and two days later well-formed young sclerotial masses occupied the same positions. These matured fully, and showed, in their microscopic structure and in their reaction for glycogen, complete identity with the sclerotia developed from the ascospores of the *Sclerotinia*. The sclerotial masses did not form a rind on the side next to the potato, and remained closely adhering to it; but this was probably due merely to the character of the substratum. It is of interest to note that the spores of the second generation from the original material failed to produce sclerotia on any of the substrata mentioned; but the positive evidence of a single culture is worth any number of failures. There is no possibility of the contamination of the successful cultures by ascospores, for at the time they were made not a single *Sclerotinia* cup was or ever had been in existence in the laboratory. The culture was made with a drop of distilled water containing a few spores, and showed no evidence of the presence of any other mycelium or spore form than

the *Botrytis*. I have preserved the block of potato with *Botrytis* threads and sclerotia as evidence of the correctness of these statements. It is, I believe, quite within bounds to say that the results described raise a very strong presumption in favor of the view that *Sclerotinia Libertiana* possesses a conidial stage of the *Botrytis* type. This view is further strengthened by the observations to the same effect made in the study of a disease of rape by Frank,* although he identified his *Botrytis* as one which is known to be connected with another species of *Sclerotinia*.

As to the identity of the *Botrytis* in question, the indefiniteness of the descriptions of the various so-called species, and the undoubted multiplication of specific names beyond all reason, render it difficult to speak with certainty. But the form on the cucumber appears to me to be identical in all respects with that previously described † as the cause of the rotting of lettuce in the greenhouse, and believed to be the form known as *Botrytis vulgaris* Fries. Some points of its structure are poorly shown in fig. 13. Unfortunately, I was not able to make infection experiments when living spore material was available; but, in view of Kissling's results ‡ with a closely related *Botrytis*, it seems probable that the conditions which govern its attacks as a parasite are similar to those above described for the ascosporic form.

Consideration of the life history above sketched shows clearly that the key to the situation, so far as the control of this disease is concerned, is to be found in the destruction of the sclerotia. If plants which show the disease be promptly removed and destroyed, and the development of sclerotia be thus prevented, while careful watch is kept for any sclerotia accidentally allowed to form, one need have little fear of serious loss in future crops, even on the same soil. It is only where diseased plants are neglected, and sclerotia are allowed to develop and fall to the ground to serve as sources of infection for the next crop, that serious attacks can continue from season to season. The control of this disease does not require even the trouble of spraying, but

* Die Krankheiten der Pflanzen, p. 530: 1880.

† Ninth Report Massachusetts Experiment Station, p. 219.

‡ Hedwigia, 1889, p. 227.

merely the practice of what should be ruling principles in every greenhouse, *cleanliness* and *watchfulness*.

In conclusion, it may be of interest to review briefly the known parasitic species of *Sclerotinia*. We need notice only those which are capable of really parasitic life, and are thus truly disease-producing fungi. *Sclerotinia Libertiana* F'k'l., the above-described species, was one of the earliest studies. Our first exact knowledge of it is due to DeBary,* Brefeld † and Mattirolo,‡ who described the sclerotia and the perfect form, while later DeBary § worked out the very interesting conditions on which its parasitic life depends. He cultivated it on a great variety of plants, including the turnip, beet, carrot, radish, potato, petunia, zinnia, bean and others. Brefeld found it attacking the Jerusalem artichoke, and Frank ‖ observed a disease of rape produced by it. It is probable, too, that the disease of hemp observed by Tichomiroff¶ in Russia is due to the same species. The cucumber has been found by Smith ** to be attacked by a fungus which he identified as *Botrytis vulgaris*, but which he regarded as only a saprophyte. It was probably the conidial stage of this *Sclerotinia*, and the discovery of its perfect form on the same host is therefore very natural. Many additions to the list of its host-plants are likely to be made.

Sclerotinia Fuckeliana DeBary is one of the best known of these forms. It attacks especially the leaves and fruits of the grape vine in Europe, and is found on the herbaceous parts of various plants, chiefly in its conidial form, known as *Botrytis cinerea*. Although, as in *Scl. Libertiana*, the conidial form usually reproduces itself persistently, the sclerotia give rise under favorable conditions, when just matured, to the *Botrytis* form. When older, they produce the spore cups of the perfect form. These facts make the demonstration of the connection of the two forms much easier than in *Scl. Libertiana*. A disease of onions de-

* Morphologie and Physiologie der Pilze, pp. 35, 60, 201 : 1866.

† Botan. Unters. über Schimmelpilze, IV., p. 112 : 1881.

‡ Nuovo Giornale Botanico Italiano, XIV., 200 : 1882.

§ Botanische Zeitung, 1886, Nos. 22–27.

‖ Die Krankheiten der Pflanzen, p. 530 : 1880.

¶ Bulletin Soc. Naturalistes de Moscou : 1868.

** Gardeners' Chronicle, XXV., p. 173 : 1876.

scribed by Sorauer* appears to be due to this species. Its conidial form has been the subject of important studies by Klein,† Müller-Thurgau‡ and Kissling.§

Sclerotinia Trifoliorum Eriks. has been shown by Kühn,|| Rehm¶ and Ericksson** to cause a serious disease of various species of clover. No conidial form has yet been connected with it. From Wakker's†† account it would seem that a very destructive disease of various bulbs (hyacinth, narcissus, crocus, scilla, etc.) in the great propagating fields of Holland is due to the same fungus. On either of its host-plants it penetrates and destroys the tissues rapidly, leaving finally only their shrivelled remains.

A disease of the European whortleberry was described by Schroeter‡‡ in 1879, and by him attributed to one of these fungi, which he called *Peziza baccarum.* The subject was taken up later by Woronin, who has distinguished§§ four closely related species that attack the fruits and leaves of European *Vaccinia.* The one which he has studied in most detail is *Sclerotinia Vaccinii* Woron. This species has a summer spore form, not of the *Botrytis* type, but very similar to our common fruit-rot fungus, *Monilia fructigena.*|||| There is no reason why these or similar species may not be found attacking our American blueberries or cranberries, and producing the "white blueberries," so often regarded, and sometimes justly, as freaks or sports.

Finally, there may be mentioned, as of interest in this connection, the disease of garden lilies studied by Marshall Ward,¶¶ and shown to be due to a *Botrytis* apparently distinct from those above mentioned, and very probably the conidial stage of an unidentified *Sclerotinia.*

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* Handbuch der Planzenkrankheiten, II., p. 294: 1886.

† Botanische Zeitung, 1885.

‡ Landwirthschaftliche Jahrbücher, XVII., p. 83: 1888.

§ Hedwigia, XXVIII., p. 227: 1889.

|| Hedwigia, IX., p. 50: 1870.

¶ Entwickelung eines Kleearten zerstör. Pilzes; Göttingen, 1872.

** Kgl. Landsbr. Akad. Handlingar: 1880. See Bot. Centralbl., I., 296.

†† Allgem. Vereen. voor Bloembollencultur te Haarlem, 1883-4; and Archiv Neerlandaises, XXIII.

‡‡ Hedwigia, XVIII., p 177: 1879.

§§ Mém. Acad. Sci. St. Petersburg, Sér. 7, t. XXXVI.: 1888; and Bericht. Deutschen Bot. Gesellschaft, III., p. LIX.: 1885.

|||| Eighth Report Massachusetts Experiment Station, p. 213; and Pl. II.

¶¶ Annals of Botany, II., p. 319: 1888.

2. The Powdery Mildew. — *Erysiphe Cichoracearum* DC. (Plate III.)

In the last report of this department* an account was given of this disease, which was then described for the first time in America. No new facts concerning it have since been learned; but as drawings intended to accompany that account were unfortunately lost in the mail, new ones have been prepared for publication in the present report, and a brief recapitulation of some facts concerning it may serve to explain these figures to those who have not the previous report at hand.

Like all the powdery mildews, this plant is a surface parasite, its vegetative threads running over the exterior of the host (fig. 14). The epidermal cells of the latter are pierced at intervals by short, thick branches, sent downward from the vegetative threads, whose office is the absorption of nourishment for the fungus from the invaded host cells (fig. 14, *h*). From the vegetative threads are also produced erect spore threads (fig. 14, *sp.*), which bear the summer spores of the fungus. These are cut off in basipetal succession by cross partitions, the apical spore being thus always the oldest and falling from the chain as soon as it is fully ripe (fig. 15). These ripe summer spores (fig. 16) germinate quickly, and serve to spread the fungus rapidly. The fact was mentioned in our previous report that the spores on diseased cucumber leaves, received from Fitchburg, Mass., and from Ithaca, N. Y., respectively, did not fully correspond in size and form, and may possibly represent different species of fungi. Their differences may be seen by comparing the figures given. While all the other figures are taken from the Massachusetts form, fig. 17 represents the larger summer spores of the New York one.

Before the publication of the previous account of this fungus, only its summer spore form was known on the cucumber, and its specific identity, which depends upon the winter stage, was therefore undetermined. The appearance of the winter form in our greenhouse has made this identification possible, and has shown that the Massachusetts form,

* Ninth Report Massachusetts Experiment Station, p. 222.

at least, is one of the most common and widely spread members of the group *Erysiphe Cichoracearum.* The winter stage consists of tiny, dark-brown, rounded capsules, consisting of a firm outer crust of compacted cells, enclosing a group of spore sacs. Within these sacs, when mature, are formed the spores. The structure of the perithecia, asci, spores and haustoria of the cucumber fungus identifies it beyond doubt as the species above named. I have not been able to duplicate the lost drawings of a perithecium, but fig. 18 shows a group of characteristic asci with spores, and fig. 19 a single ripe spore. These spores undoubtedly carry the fungus over from season to season, but nothing is yet known as to their germination and further development.

3. THE DOWNY MILDEW. — *Plasmopara Cubensis* (B. & C.) Humph

In a previous report of this station* will be found an account, with figures, of this downy mildew of cucurbitaceous plants, which, though but recently recognized in this country, has come to be a serious pest. So far as I know, its occurrence on the cucumber plant in the greenhouse has not heretofore been mentioned, though it has often been observed in the open air and in the hot-bed. This fungus was received about October 1, in large quantity, on leaves of greenhouse cucumbers, from Messrs. C. H. Chase & Son of Clinton, who report that they have suffered from its attacks for two years previous to the present. On leaves attacked by this fungus, it is not commonly sufficiently abundant to be recognized by the unaided eye, as the spore threads are rather thinly scattered over the lower faces of the leaves. But on the material above mentioned the development of the fungus was very luxuriant, perhaps from the peculiarly favorable conditions afforded by the greenhouse. The lower leaf surfaces showed the distinctly purplish tint, due to the abundant development of summer spores, which characterizes the presence of various nearly related fungi on other hosts. These individuals presented no differences in structure from those developed out of doors, but the difference in luxuriance of development was very striking.

* Eighth Report Massachusetts Experiment Station, p. 210, and Pl. II.

This parasite is very destructive under favorable conditions, but there is no reason to doubt that thorough and timely spraying will control it, at least where the host-plants are otherwise in a condition to make healthy growth.

4. Damping Off. — *Pythium DeBaryanum* Hesse.

Seeding plants of many species have long been known to be destroyed in great numbers by the affection known as "damping off." To the number of those known to be thus affected was added in a previous report* the cucumber plant, and the cause of the trouble was shown to be the same fungus to which it is commonly due in Europe. The same fungus has repeatedly been met with in the cucumber house during the past two years, and has caused much loss of time and of plants. Last fall seedlings which had started well in a bed of fresh, rich soil, just taken from a compost heap where it had lain for at least two years, were so generally attacked that nearly all were lost. The attacks were so nearly simultaneous that there can be no doubt that the fungus was generally diffused throughout the soil; and, unless it is able to propagate itself in some way of which we now know nothing, the spores from which the infection originated must have remained alive in the compost for a long time. Unfortunately, no practicable treatment can be recommended beyond the removal of affected seedlings, with the surrounding soil, as quickly as possible after they show the presence of the fungus.

5. The Leaf Blight. — *Cladosporium cucumerinum* Ell. & Arth. (Plate IV.)

Early in October we received from Messrs. C. H. Chase & Son of Clinton some cucumber plants whose stems and roots were quite healthy, while the leaves were badly wilted, and had a peculiar watery appearance. Everything indicated that here was a definite disease, as leaves on a given plant showed various stages in its progress, those in the latest stages being reduced to a mass of decaying tissue, while those in the earliest stages were just beginning to wilt and to show translucent watery spots. The senders

* Eighth Report Massachusetts Experiment Station, p. 220, and Pl. II.

reported the trouble as one quite new to them. They stated that it may show itself on any part of the plant and spread rapidly over the whole, so that all the leaves are practically destroyed in two or three days. In spreading from plant to plant, they observe, it seems somewhat erratic, attacking one here and another there, without order, but eventually taking all in the bench. It will be seen that this is a very serious affection where conditions favor, and one of much importance, from the extent of its ravages and the rapidity with which it does its work.

It was impossible to recognize the presence of any fungus with the unaided eye, and the fact of such presence was at first doubted. But microscopic examination demonstrated the presence on all diseased leaves, even in the earliest stages, of the mycelium and spore threads of a fungus of the imperfect form germs *Cladosporium*. The mycelium of the fungus (figs. 25 and 26, *m*) grows freely within the leaf tissue, and after it is well developed sends branches to the surface through the pores (*stomata*) of the lower surface of the leaf. Frequently several of these threads come to the surface through a single pore. Just at the mouth of the pore there is usually formed a closely packed mass of small cells, which originates from the threads, but whose precise development I have not followed. This may be called the *hyphal knot* (fig. 26, *a*), and is ordinarily large enough to conceal, nearly or wholly, the guard cells of the pore. From this knot arises a cluster of few or several erect spore threads (fig. 25). These threads, at first simple, may remain so indefinitely, cutting off the simple spores (fig. 25, *sp.*) from their ends; or they may branch, producing at their ends short cells with all the characteristics of spores, which may remain attached to the threads and undergo further development. This results in the most highly complicated form of the spore threads, and consists in the successive acropetal production of sprout buds from the originally terminal joints, so that there are formed chains of successively smaller and smaller cells, producing a much branched and very complex appearance (fig. 26). All the cells thus produced appear to be functional spores, and the rapid spread of the disease in the greenhouse shows how promptly they are capable of

germinating and infecting fresh tissues. Unfortunately, I had no suitable plants for infection at the time the material was received; but a careful study of the various stages of the disease presented by the different leaves of a plant affords little room for doubt that this fungus form is its efficient cause.

The only mention of a disease of this host caused by a similar fungus that has come to notice is that by Arthur,* who has described the development of decayed spots on cucumber fruits, observed by him in New York and Indiana. In this case the cause of the decay, which was a source of much loss, appeared to be a *Cladosporium* form, which the writer called *Cladosporium cucumerinum* Ell. & Arth. It is impossible to say that our leaf-destroying form is the same as this which attacks the fruits, but there is no reason for assuming them to be different. On the other hand, it is by no means certain that either the leaf or the fruit form is distinct from forms previously known on other hosts. Indeed, the accumulation of evidence that the common form known as *Clad. herbarum*, until very recently regarded as only saprophytic, is capable of actively parasitic life, must weaken one's doubt that most of the related forms possess the same capacity. Our knowledge of the *Cladosporium* forms is very fragmentary, and there can be no doubt that a thorough study, based on detailed cultures of the various forms, would result in a great reduction in the number of so-called species. For the present, then, our parasite may bear the name given by Ellis and Arthur, in the sense that it is a *Cladosporium*, attacking cucumber plants, without any necessary implication as to its real distinctness from forms attacking other host-plants.

It seems altogether probable that prompt spraying as soon as this disease begins to appear will prevent its spread to healthy plants. But, in view of its rapid progress, a very little delay may be fatal.

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* Sixth Report New York Experiment Station, p. 316, 1888; and Nineteenth Bull. Indiana Station, 1889.

6. The Leaf Glaze. — *Acremonium* sp. (Plate IV.)

Early in 1891 cucumber leaves were received from Fitchburg, Mass., whose lower surfaces showed delicate glairy films of fungus-threads, as described in our last report.* These leaves came from very badly diseased plants, which had received no benefit from the application of fungicides, although it seemed probable that the accompanying fungus bore some causal relation to the trouble. The fungus-threads on the leaves were quite sterile when received, but, when the leaf bearing them had lain two or three days in the moist chamber, produced spores abundantly. Drawings showing the structure of the fungus and the germination of its spores were made at the time and laid aside, in the hope that additional material would make possible an extension of our knowledge of the disease and of the relations of the fungus in question to it. As it has not again been met with, no further information can be given concerning it, and we can only complete the record of our meagre knowledge of the subject by publishing herewith the drawings mentioned.

The film on the leaves consists of numerous delicate, colorless and closely interwoven threads. These give rise in the moist chamber, and probably sooner or later under natural conditions, to short simple threads at right angles (fig. 27), at the slightly knobbed apex of each of which is produced a single somewhat kidney-shaped spore (fig. 28). In water these spores swell up and produce stout germ tubes of considerable length, similar to the original threads of the film (fig. 29). This is all we know of the fungus. It is to be hoped that some investigator may be able to study it in detail, with the disease it accompanies, and to answer the many interesting questions concerning it which still await an answer.

7. Other Diseases.

Two other diseases of some importance, which have not yet been observed in Massachusetts, but may at any time be met with, may be briefly mentioned in conclusion.

Halsted has described † a serious rotting of cucumbers and

* Ninth Report Massachusetts Experiment Station, p. 227.

† Botanical Gazette, 1891, p. 303; and Twelfth Report New Jersey Station, p. 273.

other cucurbitaceous fruits, which is accompanied by and seems to be due to a form of *Bacterium*. It appears to be readily communicated by inoculation, and sometimes causes very serious and rapid loss.

At various times and in various places the fruits, and sometimes stems and leaves, of the cucumber have been observed * to be attacked by a disease of the type now generally termed anthracnose, produced by some of the fungus forms included under the name *Glœosporium*. The forms have been called by different names by different writers, and it may be doubted whether they are all identical. Some of them appear capable, under some conditions, of great destructiveness. Nothing is known as to the perfect forms of the fungi in whose life cycles they constitute stages.

II. A Violet Disease. — *Phyllosticta Violæ* Desm.

In the summer of 1891 my attention was called by W. D. Philbrick, Esq., of Newton Centre, to a disease of cultivated violets (*Viola odorata*), from which he and other growers had suffered severely for several years. A visit to his and neighboring grounds showed the plants, at that time growing in the field, to be badly attacked. The leaves showed very numerous circular whitish spots, averaging about an eighth of an inch in diameter. In many instances these spots had run together, and in the worst cases whole leaves were covered by the spots and involved in a general decay. From the parts of the field where the trouble was most serious there arose an almost sickening odor of decay, and here nearly every plant was badly affected. It was very noticeable that the most commonly grown variety, the Marie Louise, was the greatest sufferer, while the double Russian, with its stockier foliage, was far less attacked, and the single Russian least of all. Another striking fact, and one which one would hardly expect to be a fact concerning a fungous disease, is that plants growing in the shade of a tree and so protected by it as to be still wet with dew in the afternoon were the healthiest in the field, and showed hardly a trace of disease. The impression made by an inspection of the

* Gardeners' Chronicle, 1876: V., pp. 438 and 505; VI., pp. 175, 269, 303, 336, 370, 400, 495. First Report Insect and Fungous Pests of Queensland, p. 175: 1889.

fields was very decidedly in favor of the supposition that the trouble in question was a disease of the leaves, due to the organism causing the spots.

Close inspection of the spots showed tiny black pustules on each; and these proved to be the conceptacles or spore fruits of the fungus, whose development in the leaves causes the death of their tissue in certain regions, and thus produces the spots. The conceptacles appear to belong to that fungus form known as *Phyllosticta Violæ* Desm. It is one of the so-called "imperfect fungi," whose perfect or winter-spore form and other summer-spore forms have not yet been determined.

In the fall of 1891 both healthy and diseased plants were received from Mr. Philbrick, and were set in a bench and in a box in the greenhouse. Those which were diseased when sent did not become established so readily as the others, and, although they lived for a time, they eventually succumbed and other diseased plants were set in their places. These met the same fate. Plants with dead or dying foliage were several times removed and carefully examined throughout. In some cases the roots appeared perfectly healthy, but in others there were plainly found the characteristic root galls produced on many plants by a *Nematode* worm. These were, however, abundant in no instance, and the roots were never sufficiently involved to account for the death of the plant.

With a thought of the possibility of a complication of the fungous trouble by some other affection, Mr. Philbrick had been asked to watch carefully for any abnormal appearance of the roots, and especially for any root galls, when transplanting his violets from the field to the greenhouse. He reported that, among three thousand plants, the roots of all but six seemed quite healthy. These six plants were sent to the station, and were found to bear the familiar *Nematode* galls in small numbers. Four of the affected plants were set in a box and submitted for a month to precisely the same treatment. After they had become well established, they were separated into two lots of two each by a heavy tin plate of the full size of the box. The plants of one lot were now watered every few days with about half a pint each of a solu-

tion of one part of permanganate of potash in two thousand parts of water. Those of the other lot received none of the permanganate, but an equal quantity of water, and were, in other respects, under identical conditions. In three weeks a difference between the two lots was evident, and in a month it had become very conspicuous. The foliage of the treated plants was deeper green and much more abundant than that of the others. Ultimately the plants which received no permanganate died completely, their leaves turning brown over their entire surfaces, but showing no trace of the spot fungus. The plants which received the permanganate remained vigorous and healthy until taken out in the spring.

In view of this experience, Mr. Philbrick was advised to try the same treatment on a larger scale. This he did, and reported, after an experiment extending through a large part of February and March, 1892, that he could see absolutely no difference between treated and untreated plants. There is no reason for doubting and every reason for believing that this experiment was properly carried out, but its results are puzzling, in view of our experience with a few plants at Amherst. In the latter case the plants were in excellent soil, and the result cannot be attributed wholly to any possible fertilizing effect of the potash salt. It should be said, too, that the plants which died had still an apparent abundance of healthy roots, and their death did not appear to be due to the few Nematodes which were present. This view is sustained by the fact that plants died with the same symptoms in the bench, which showed no trace of Nematodes or of any disease of the roots. It is, however, true that the Nematodes in the roots of the treated plants disappeared, presumably as a result of the treatment, which has been used with success against root-attacking Nematodes.

In view of all the above facts, it seems most logical to conclude that, in the case of Mr. Philbrick's violets and in the death of plants at Amherst, root Nematodes have little or no share. We are left, then, to consider the only other foreign organism observed in connection with the trouble, the leaf-spot fungus. This, it may be said, has been believed by Mr. Philbrick from the first to be the efficient cause of the disease. In April, 1892, a lot of plants, both healthy

and badly attacked by the leaf-fungus, both those which had and those which had not been treated with permangate, were received from Mr. Philbrick. These were divided, as is the custom with violet growers, so as to leave a good portion of root to each, and set in good soil on one of the station plats. As they made new leaves no signs of the fungus were seen, and it was determined not to spray them at all unless the appearance of the fungus should demand it. Unfortunately for our study of the disease, the fungus did not appear during the summer, except on a very few leaves, and no test of the efficacy of spraying as a preventive of its spread was possible. Mr. Philbrick's experience was different. He sprayed a part of his plants with the ammoniacal carbonate of copper until about the middle of August, when a few days of warm, damp weather occurred, and the disease spread rapidly and fatally. As he could see no difference in the degree to which sprayed and unsprayed plants suffered, he gave up the treatment in disgust, and lost nearly all his plants. If it be true that the leaf-spot fungus is the cause of this very destructive disease, from which many violet growers near Boston suffer, — and all the facts now at hand point to this as the correct conclusion, — there is no apparent reason why thorough and persistent spraying with one of the copper preparations should not prove very efficient in holding it in check. And Mr. E. O. Orpet of South Lancaster informs me that he has had excellent success with this treatment. The failure above quoted was probably due to some error in carrying out the treatment. So far as I have been able to learn the details, the intervals between the applications were apparently so long as to leave the plants unprotected for a time in each interval. One of these periods of exposure coming in weather favorable to the spread of the fungus would be quite sufficient to account for the result; for, as has been so often said, a plant once infected is lost. The secret of immunity lies in complete protection of the plants against infection. A word more may not be out of place here. It is a common practice of growers of violets to keep them in activity during the entire year, forcing the vegetative growth during the summer and fall, and forcing the blossoms

during winter and spring. That this practice is exceedingly weakening to the plants, and renders them more susceptible to the attacks of disease-producing organisms, cannot be doubted. The more rational practice of some growers, of giving the plants a rest in the cold frame during a part of the year, cannot fail to produce more sturdy plants; and it may be doubted if it is not in the long run more profitable, when all factors are taken into account.

III. The Black Knot of the Plum. — *Plowrightia morbosa* (Sz.) Sacc. (Plate V.)

Work on other diseases has crowded out much which has been planned in continuation of that already reported * on this important trouble, but a few words may be added, especially in regard to the practical treatment of the disease. During the past year cultures with the ascospores and pycnospores of the fungus have been carefully repeated, with results in every case identical with those reported in our previous account. On bread saturated with an infusion of prunes, pycnospores, taken from pycnidia developed from ascospores on prune gelatine, produce a very luxuriant mycelium. This mycelium, at first white, soon assumes a salmon-red tint, and later becomes black. The first pycnidia on such a culture were ripe in five days from the sowing of the spores; but others continued to form until the entire surface of the substratum was covered by a compact pycnidial crust. This pycnidial form seems to be very rarely developed under natural conditions, but there can be no doubt that it belongs to the life cycle of the "black-knot" fungus. It seems very probable that some relation exists between its suppression and the facts next to be detailed, but this is not the place for the discussion of such probabilities. Careful experiments have been made as to the power of the pycnospores to infect the living tissues of the host-plant. It is clear that one or more of the spore forms of the fungus must possess such power, and it was hoped that experiments with each of the known forms might before now have been made. But this has not been possible. In case of the pycnospores

* Eighth Report Massachusetts Experiment Station, pp. 200–210, and Pl. I.

it has been found that they are quite incapable of attacking any of the living tissues of the host. They have been sown on sound and on injured leaves, and on stems of various ages, on those of the season and those of one, two and more years old. Whether sown on the intact surface of the stem, or allowed free access to the freshly exposed living tissues of the inner bark (Phloëm), the results have been the same. No development of knots has followed any of the sowings, nor has any trace of mycelial threads been found in the tissues exposed to them. It seems pretty certain, then, that they play no important part in the spread of the fungus.

Prevention. — Since we do not yet know the details of the infection of the host-plant by this fungus, we are not in a position to use fungicides intelligently. It is doubtless true that spraying at intervals during the whole period of the ripening and escape of both winter and summer spores, namely, from January to June, will largely prevent the attacks of this disease. But it is hardly less to be doubted that a complete filling of this important blank in the life history of the fungus will enable us to reduce the period of spraying to a relatively short one. On the other hand, I am convinced that the disease can be largely controlled without spraying, if fruit growers will learn to recognize its earliest appearance. The great difficulty at present lies in the fact that a few small knots, even when fully grown, often escape notice, and so serve as sources of infection; and indeed, the average man does not realize that his trees need attention and that the fungus is getting the better of them until they are so covered with knots as to be practically worthless. While, as for the early stages of the knot, before either of the spore forms have developed, no one thinks of looking for them and removing them when removal is of some avail. It is very rarely that a tree is badly attacked the first season. Commonly the beginning is the appearance of one or two small knots, of very little consequence alone, but sufficient to infect the whole tree in two or three years, if left. After a very little experience any one can recognize the forming knot even before it bursts the bark, and before it has done serious mischief. No one would mistake the large knot on the middle branch in Pl. V.; but it has

matured two crops of spores and done its work, and to remove it is a waste of time and labor. But just beneath it on the branch, and on each of the side branches, is a smaller and less conspicuous swelling, whose bark is just bursting. These swellings are knots a year younger than the large one, and have ripened no spores. The thorough removal of these is preventive work of the best kind. I firmly believe that a man who will start with healthy trees and will carefully examine them for these young knots about the last of April in every year (for the climate of Massachusetts), thoroughly removing and burning all that are found, need have very little fear of black knot. Where a small branch is attacked, one need only cut it off some distance below the knot. Where, as will rarely happen if trees are carefully looked after annually, a large branch whose removal would seriously injure the tree is involved, the knot may be carefully dug out until healthy bark is reached in all directions. The exposed tissues may then be painted over with a heavy coat of red oxide of iron in linseed oil. This coating will serve as a protection, and will also, by its color, enable one to readily find the treated spots and to watch them for any further development of the fungus. The application of kerosene to the knots, while doubtless fatal to the fungus, is likely to be equally so to the tissues of the tree, and is not to be recommended as a general practice.

For the greatest success in dealing with the black knot, it is, of course, a prime necessity that sources of infection shall be reduced to a minimum. Neighboring plum or cherry trees or wild plants of the various native species of plums and cherries may serve as propagators of the fungus, and make one's labors much greater and his chances of success much smaller. The great desideratum in this regard is an intelligent and active public sentiment, which shall compel the destruction of all such plague-breeders. A few of our States have accepted the suggestion that the matter be made the subject of legislation, and have enacted laws to compel the destruction of trees infected by the black knot. One may, however, well doubt the utility of such legislation. It is interesting, as showing the beginning of toleration for subjects which, not long ago, would

have been thought unworthy of serious attention. But the enforcement of thorough-going legislation is not possible without the active support of public sentiment; and a public sentiment sufficiently aroused to execute the law would accomplish the desired result without legislation.

IV. Grain Rusts (*Puccinia* sp.).

Last spring an attempt was made by this department to enlist the practical farmers and gardeners of the State in aid of a plan for the organization of a system for the report of the prevalence of plant diseases in any locality. It has been manifestly impossible for the writer to travel about the State, and, at the same time, to carry on studies in Amherst, and the value of organized co-operation has been long realized. Therefore a special circular to those concerned was widely distributed, and it was hoped, in view of the interest in the work of the department which had been shown in some quarters, the response might be encouraging. It proved, however, disappointing in a marked degree. While five or six of the most intelligent cultivators in the State responded promptly, they remained the only persons who did so. This test must prove interesting to pathologists at least, as showing what support they may expect at present from people reputed to possess a high average degree of intelligence. It is clear that agriculturists and horticulturists in general are not yet willing to go out of their way even to aid work carried on in their interest and for their benefit. And it is the experience of the writer that only the most wide-awake of them are willing to avail themselves of the results of such work, if it involves the least deviation from the old ruts. But it is noticeable that those who are alive to the results of modern investigations are not those who complain that "farming doesn't pay."

It had been hoped to obtain from correspondents pretty full information concerning the rusting of grains during the season, as this constituted the special subject of inquiry for the year of the International Phytopathological Commission. In the absence of information from these sources, the writer has been compelled to rely upon others, especially the various official crop reports. It seems that, so far as New

England is concerned, the season has been far less favorable to the development of the rust fungi than in previous years. The losses appear to have been very light from this cause, and it has not been possible to obtain data of value concerning them. The only crop distinctly mentioned as suffering at all has been oats, and it is by no means certain that the cause of its affection was one of the species of *Puccinia* to which the true rusting of grain is due. The season of 1892 must, therefore, be set down as one of unfavorable conditions and negative results in New England.

V. Notes on Various Diseases.

1. The Powdery Mildew of the Strawberry (*Sphærotheca Castagnei* Lév. ?) (Pl. III.) was brought to my attention on the experimental plats of the Agricultural College, early last summer. The affection shows itself in a peculiar curling or inrolling of the leaves, which causes them to take a somewhat cup-like form. If the lower surfaces of the curled leaves be carefully examined, they will be seen to be frosted by minute white threads scattered rather sparingly over them. They are not grouped in more or less circumscribed spots, like those of the similar mildew of the cucumber, previously described. But microscopic examination shows that their structure is essentially like those of the "*Oidium*" form of the latter. Erect threads arising from the mycelium (fig. 20) cut off the summer spores from their ends in basipetal succession, and these fall off as they mature (fig. 21). The form and size of these spores (fig. 22) confirm the impression produced by the habit of growth that we have here to do with a species quite distinct from that which attacks the cucumber. Although I have not observed the perfect spore form, it is probable that the fungus with which we have here to do is *Sphærotheca Castagnei*.

This fungus does not appear to be very destructive to the strawberry, or to have attracted much attention. It has been briefly described by Arthur,* who observed it in New York. He found it attacking the fruit as well as the foliage,

* Fifth Report New York Experiment Station, p. 291, 1887.

and indeed doing its chief harm in rendering the former insipid and worthless. I have not seen it on the fruits, but it may be likely to be found upon them, and in this aspect the fungus may assume, under favoring conditions, considerable economic importance. Suggestions as to treatment may be found on subsequent pages.

2. THE POWDERY MILDEW OF THE GOOSEBERRY (*Sphærotheca mors-uvæ* (Sz.) B. & C.) (Pl. III.) was received, last summer, from W. C. Strong, Esq., of Waban, on the leaves, twigs and berries of the "Triomphe" gooseberry, a variety which has been claimed to be mildew-proof. In the present case the utter groundlessness of such a claim was strikingly shown, and afforded further evidence that we are safe only in speaking of varieties as more or less liable to the attacks of fungous diseases. It is not probable that any of our horticultural varieties are in any absolute sense disease-proof, and it may fairly be doubted if we shall ever originate such, without sacrifice of more essential features, even with constantly increasing understanding of the requisite qualities.

This fungus is very closely related to that last described, and differs from it only in very unimportant particulars. The mycelium forms a dense felt over the infected parts of the host-plant, and in the early part of the season is nearly colorless, and produces the "*Oidium*" form in abundance. Later, the mycelium becomes quite dark-colored, and gives rise to the perfect spore form (figs. 23, 24). As above indicated, all the younger, succulent parts of the plant may be involved, and thus not only is the season's fruit destroyed, but the normal production of new wood and preparation for another season is prevented. This gives to the fungus great economic importance, especially since it is widely distributed. It has been frequently mentioned by writers on plant diseases, and the accounts by Arthur * and Halsted † may be consulted for further information. Notes on the treatment of this class of diseases are given later.

* Sixth Report New York Experiment Station, p. 349, 1888.

† Mycological Report, United States Department Agriculture, 1887, p. 373, with plate.

3. The Cluster Cup of the Gooseberry (*Æcidium Grossulariæ* Schum.) occurred also on some of the leaves sent by W. C. Strong, Esq., as mentioned in the previous note. Gooseberry leaves and berries very badly attacked were also received, about the same time, through the "New England Homestead," from Mr. C. C. Stickney of Ballardvale. From the facts which came to my notice during the season, it would appear that this fungus has been more than usually abundant this year. It may commonly be found in early summer on gooseberry bushes, and occurs also on some of our wild and cultivated species of currants (*Ribes*); but it is rarely very destructive. It may, however, as was seen this year, assume serious proportions, practically destroying a large part of foliage and fruit. It seems not to have attracted much attention as a cause of loss, but has lately been said by Pammel* to be quite destructive in Iowa. The form we are considering is the "cluster-cup" stage of one of the *rust* fungi. The bright yellow cups occur in groups on somewhat swollen and discolored portions of the leaves or berries, and contain the chains of spores by which the further development of the species is accomplished. It is probable that, as in other rusts, this "cluster cup" is followed by *red-rust* and *black-rust* forms. But, as these are not known to be developed on the same host-plant, they are probably produced on a second one. This would place the present fungus among the *heterœcious* rusts. So long, however, as we do not know its life history, we cannot avail ourselves of all the means of combating it.

When the cluster cup begins to appear, in spring or early summer, the harm for that season is done, and cannot be avoided. Yet, if the discolored spots be watched for and the affected parts picked and burned before the cups have burst open and discharged their spore, one may hope to escape attack in a considerable measure the following year; and the annual repetition of this practice should result in comparative immunity from the fungus. This recommendation is based on the justifiable assumption that the cluster-cup form requires for its reappearance the development of

* Journal of Mycology, VII., p. 101, 1892.

the other spore forms of the fungus, and that this last development cannot occur if the dissemination of cluster-cup spores be prevented. That this is true has not yet been proven, but, in the light of what we know of other rust fungi, it may fairly be assumed until more positive information is available.

4. A Hazel Fungus (*Cryptosporella anomala* (Pk.) Sacc.) (Pl. IV.) was left at the station in April by Mr. Henry Graves of Palmer. He reported it as killing the canes of the European hazel (*Corylus avellana*) in a plantation owned by him, and as attacking an annually increasing portion of the plantation. The fungus proved to be that known by the above name, which was first described by Peck,* who observed it on the same host at Albany, N. Y., as *Diatrype anomala.* It appears in the form of protuberances with elliptical bases (fig. 30) that burst the bark and arise rather thickly from the affected portion of the branch (*a*, fig. 30), which is sunk below the surface of the healthy part. A transverse section of the branch passing through one of these protuberances shows well the structure of the fungus and its relation to the host-plant. The interior of the protuberance, which is the fructificative part of the fungus, is seen to contain numerous black, flask-like structures, whose tips reach the surface of the protuberance (fig. 31). Within the cavities of these flasks are formed the very numerous spindle-shaped spore sacs (fig. 32), each containing, when ripe, eight colorless, elliptical spores. It is very noticeable that, in the part of the branch occupied by the fungus, the inner bark, elsewhere a distinct band of tissue, is shrunken to a narrow black line between the wood and outer bark (*a*, fig. 31). This reduction in the thickness of the inner bark explains at once why the surface of the affected parts is sunken below the rest of the surface, and shows that the chief seat of the vegetative activity of the fungus is in the rich growing and conducting tissues of this part of the branch. The destruction of these tissues must, in any event, have serious consequences for the plant; and, if the entire circumference of a cane becomes involved,

* Twenty-eighth Report New York State Museum, p. 72, 1879.

the result is that it is girdled, and the whole of it beyond the point of girdling dies. The attacks of this fungus on its host-plant are essentially similar in their results to those of the black knot on the plum, though the immediate effect on the inner bark is here one of atrophy, while in the latter case it is one of hypertrophy. The present fungus is also nearly related to the black-knot fungus, but its life history is not yet at all known. What other spore forms constitute stages in its life cycle we have yet to learn. Therefore, it is impossible to give any more definite suggestions for avoiding it than to recommend that infected branches be cut away well below the point of infection and burned as soon as they are seen to be infected. This precaution, if taken in season, will prevent the dissemination of the spores described above, and should thus prevent the development of other spore forms dependent on them, and the infection of new branches.

VII. Treatment for Powdery Mildews.

In pursuance of the plan indicated in our last report,* we conclude the present one with recommendations for the avoidance of loss from the attacks of some chosen groups of fungi. The group selected in the present case is that embracing those fungi which are known as the powdery mildews. These parasites attack a considerable number of cultivated plants, and, as has been seen, sometimes cause extensive losses. They are among the commonest fungi of the greenhouse, but are equally common in summer, in the open air. Among the plants most often attacked by some one of the powdery mildews in the greenhouse are the cucumber, grape, rose, verbena and other florist's plants. Out of doors, the pea, gooseberry, strawberry, and young plants of the apple and cherry often suffer from them.

The appearances produced on their host-plants by three species of powdery mildews have already been described in this report. In general, it may be said that it is in the summer spore stage that these fungi are most harmful as disease producers. In this stage they may form dense white "floury" patches on the host, usually on its leaves, or the

* Ninth Report Massachusetts Experiment Station, pp. 243, 244.

spore threads may be quite sparingly developed, so that only a faint frosting is to be seen. In attacks of much severity there is commonly a discoloration, followed finally by the drying up of the tissues affected. As has been seen above in our discussion of some diseases due to these fungi, they are surface parasites. The whole fungus grows on the exterior of its host, except the small absorbing organs, which penetrate only the superficial cells. And this fact makes it much easier to deal with these fungi than with those which are truly internal parasites, since practically the whole of the fungus is exposed to the contact and action of any fungicides applied to the surface of the host-plant.

It should not be necessary to insist upon the prime importance of healthy conditions, so repeatedly emphasized in these reports, and it may be assumed that it is not necessary. Supposing, then, that reasonable precautions against the appearance of fungous disease have been taken, and that one of the powdery mildews appears, what can be done? The question may be discussed under two heads, namely, What can be done for plants in the greenhouse? And for those in the open air? If the disease appears in a greenhouse, either of the applications to be recommended for out-of-door plants may be used with equal success. But, if the house can be tightly closed, we have at hand a simpler, and, from the testimony of practical men, an even more satisfactory, means of treatment. This consists in filling the air of the tightly closed house with the vapor of sulphur, which is fatal to these surface parasites, without injuring their host-plants, if the exposure be not continued much beyond half an hour at a time. After this treatment ventilators should be opened, and the house given a thorough airing. The treatment may be repeated whenever the reappearance of the fungus shows it to be necessary. The sulphur vapor is easily produced by heating the flowers of sulphur to a temperature somewhat above its melting point, and keeping it at that point as long as desired. A porcelain-lined iron vessel for the sulphur and a small oil stove for heating constitute the entire outfit needed for a small house. For a large one as many such outfits may be used as are required to yield vapor enough to saturate the atmosphere of the room. Great care

must be taken that the sulphur does not become so hot as to take fire, as a brief exposure to the fumes of burning sulphur will kill cultivated plants, as well as fungi. But a little experience will soon enable one to set the flame of the oil stoves at such a height that it can be safely left to do its work.

If the plants to be protected are out of doors, it is evident that we cannot use sulphur vapor. Here we must rely on a direct application to their surfaces. Dry flowers of sulphur scattered upon the plants or blown upon them with a bellows is often of considerable service. But a solution sprayed upon the plants, by means of some of the spraying machines recommended in previous publications of this department,* is much more efficient. Formulæ for several solutions may be found in the publications just referred to,* but that most generally applicable and most satisfactory in its application and in its results is the ammoniacal carbonate of copper. The formula for this fungicide may be, for convenience, repeated here: mix one ounce carbonate of copper with five ounces carbonate of ammonia, and dissolve in one quart hot water. When dissolved, add sixteen gallons water. This may be used to thoroughly spray the plants as often as the presence of the fungus in harmful quantities shows it to be necessary. For spraying a few plants only, such as a few rose or gooseberry bushes, hand sprayers may be purchased at a price much below that of the cheapest knapsack sprayer. But care should be taken that the apparatus used throws a very fine, mist-like spray. Full directions and suggestions as to spraying in general may be found in the previous publications of this department on the subject.

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* See Bulletin No. 39, Massachusetts Experiment Station, and Ninth Report Massachusetts Experiment Station, pp. 239, 240.

EXPLANATION OF PLATES.

[*All figures are magnified 540 diameters, except where otherwise specified.*]

PLATE I.

SCLEROTIUM DISEASE OF CUCUMBER (*Sclerotinia Libertiana* F'k'l.).

Stems and young fruit attacked by the disease, showing mycelium of the fungus, chiefly at the nodes of the stems, and some external sclerotia. *a*, an early stage, the stem still green; *b*, later, the internode shrinking, and a sclerotium near the upper node; *c*, a late stage, the parenchyma largely destroyed, and the stem yellow; *d* and *e*, at about the same stage as *b*; *fr.*, a young fruit, showing mycelium and sclerotia. Natural size. From a photograph of fresh specimens.

PLATE II.

SCLEROTIUM DISEASE OF CUCUMBER (*Sclerotinia Libertiana* F'k'l.).

Fig. 1. An elongated sclerotium from the interior of a stem. Natural size.

Fig. 2. An irregular sclerotium from the exterior of the host-plant. Natural size.

Fig. 3. A sclerotium somewhat advanced in "germination," with two stalks. Natural size.

Fig. 4. Two views (*a* and *b*) of the same sclerotium, with fruit stalks, *b* four days older than *a*. Natural size.

Fig. 5. Two views of another "germinating" sclerotium, taken four days apart. Natural size.

Fig. 6. A section from the interior of a mature sclerotium. × 350.

Fig. 7. One of the fruit stalks shown in fig. 3, in vertical section. × 19.

Fig. 8. Three asci and two paraphyses from a well-developed cup. One ascus with forming spores, one with fully formed spores, and one after the escape of its spores, *sp.*

Fig. 9. Three ascospores germinated in water, after one day.

Fig. 10. Three ascospores after one day in prune infusion.

Fig. 11. A well-developed young attachment organ. × 350.

Fig. 12. A part of an old attachment organ. × 350.

Fig. 13. Spore threads and conidia (*sp.*) of *Botrytis* form, showing, *y*, young threads before the formation of spores, and, *o*, old threads after the falling away of the spores. × 200. *a*, conidia more magnified. × 540.

PLATE III.

POWDERY MILDEWS.

Figs. 14-19. Of cucumber (*Erysiphe Cichoracearum* D. C.).

Fig. 14. Epidermis of upper surface of leaf, with mycelium, *m*, of fungus giving rise to haustoria, *h*, and spore threads, *sp.*

Fig. 15. Three spore threads, with spores in various stages of development.

Fig. 16. Two ripe summer spores not yet fallen apart.

Fig. 17. Two ripe summer spores of a similar fungus from Ithaca, N. Y.

Fig. 18. A group of six spore sacs (*asci*), with spores, from the same perithecium.

Fig. 19. A ripe ascospore.

Figs. 20-22. Of strawberry (*Sphærotheca Castagnei* Lév. ?).

Fig. 20. A bit of mycelium, with a spore thread. × 200.

Fig. 21. The upper part of a spore thread, with developing spores.

Fig. 22. Two ripe summer spores.

Figs. 23-24. Of gooseberry (*Sphærotheca Mors-uvæ* (Sz.) B. & C.).

Fig. 23. The single spore sac produced in a perithecium, with spores.

Fig. 24. Four ripe ascospores.

PLATE IV.

CUCUMBER DISEASES.— *Hazel Fungus.*

Figs. 25-26. Leaf blight (*Cladosporium cucumerinum* Ell. & Arth.).

Fig. 25. Epidermis of lower surface of leaf, with stomata, *st.*, showing mycelium, *m*, and hyphal knots, giving rise to spore threads. *sp.*, detached spores of the fungus.

Fig. 26. Mycelium, *m*, and hyphal knot, *a*, giving rise to spore threads, the latter with highly developed spore chains.

Figs. 27-29. Leaf glaze (*Acremonium* sp.).

Fig. 27. Mycelium giving rise to numerous spore threads.

Fig. 28. Ripe spores, fallen from the threads.

Fig. 29. Spores germinating in water.

Figs. 30-33. Hazel fungus (*Cryptosporella anomala* (Pt.) Sacc.).

Fig. 30. A piece of a branch of hazel, showing the depressed region occupied by the fungus, *a*, and fourteen of its compound spore fruits. Natural size.

Fig. 31. A vertical section, showing five spore cavities, through a spore fruit lying at the margin of the infested area, showing the wood of the branch, *w*, the inner bark, *a*, in normal condition at the right and destroyed by the fungus at the left, and the outer bark, *o*. × 3.

Fig. 32. An ascus with its eight spores. × 940.

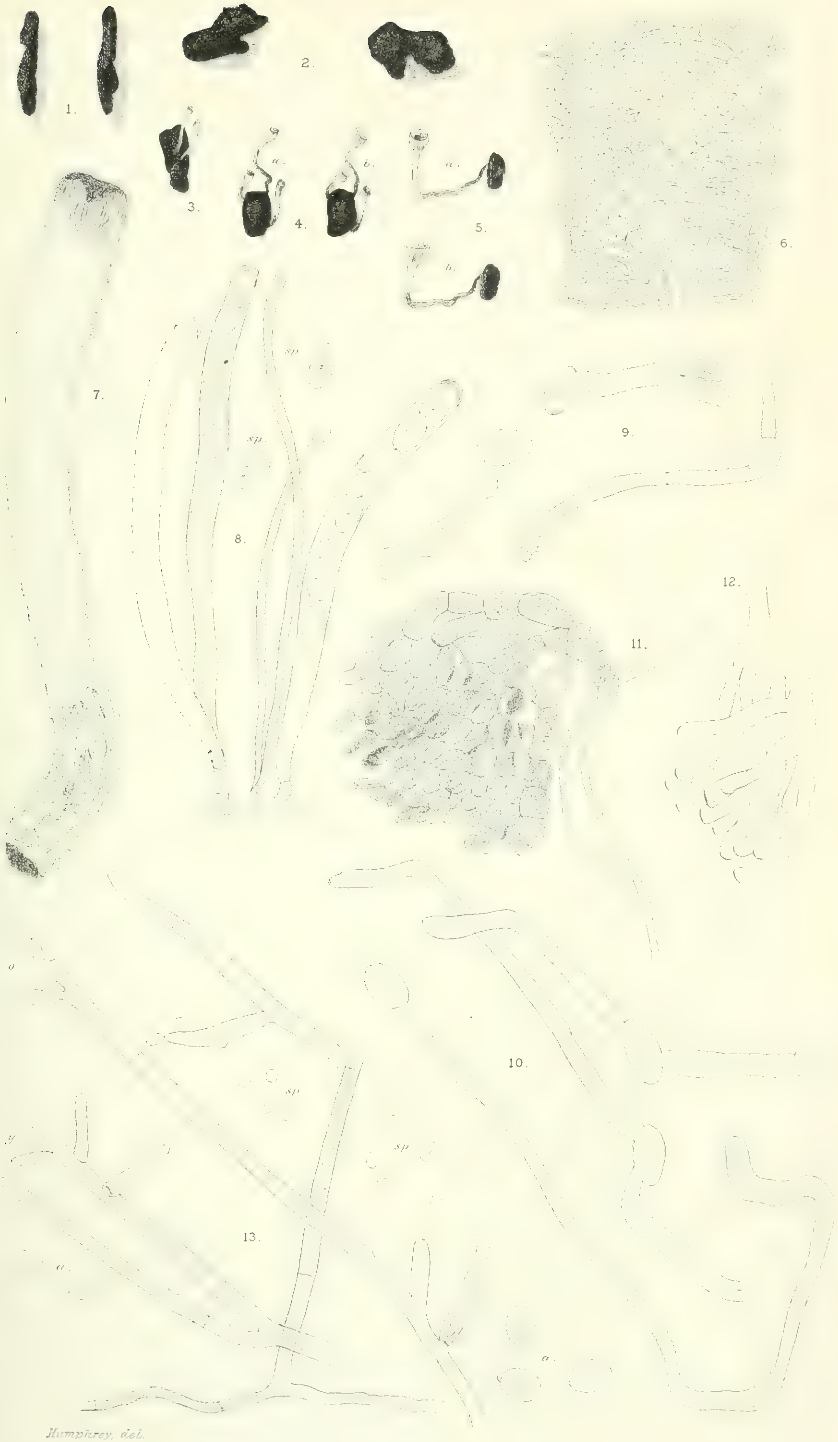
Fig. 33. Three ripe spores. × 940.

PLATE V.

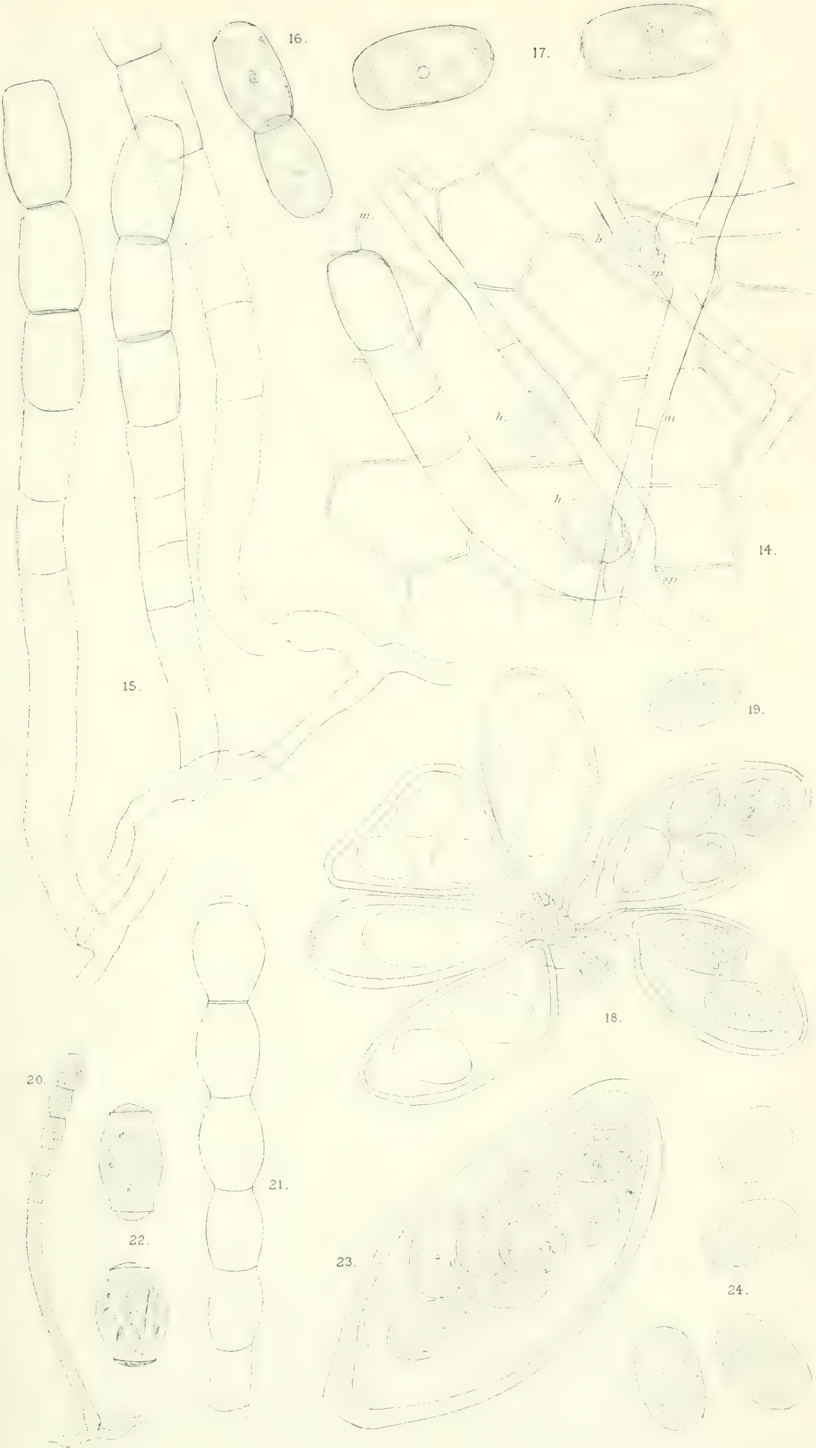
THE BLACK KNOT OF PLUM AND CHERRY (*Plowrightia morbosa* (Sz.) Sacc.).

Three young branches from the wild black cherry (*Prunus serotina*), taken about May 1, showing two stages of the knot. In the large knot, *o*, the development and escape of the winter spores has just been completed, and its activity is past. The three small knots, *a*, just bursting the bark, are a year younger than the large one, and are about to begin the production of their summer spores. Natural size. From a photograph.

SCLEROTIUM DISEASE OF CUCUMBER.

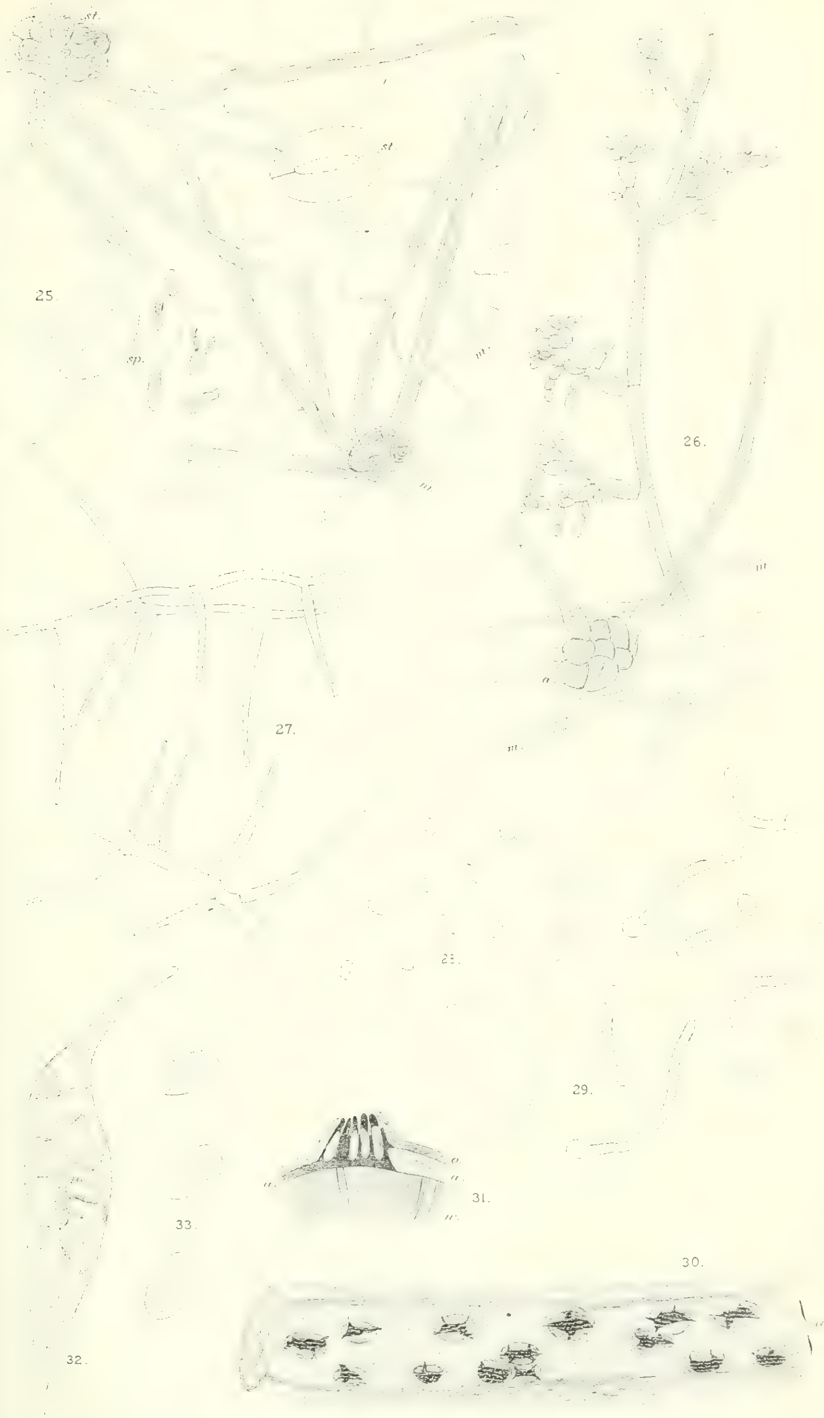


SCLEROTIUM DISEASE OF CUCUMBER.



Humphrey, del.

POWDERY MILDEWS



Humphrey, del.

CUCUMBER DISEASES. — HAZEL FUNGUS.

BLACK KNOT OF PLUM.

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

I. Communication on Commercial Fertilizers: —

1. General Introduction.
2. State Laws for the Regulation of Trade in Commercial Fertilizers.
3. List of Licensed Manufacturers and Dealers from May 1, 1892, to May 1, 1893 (51).
4. Analyses of Licensed Fertilizers (185).
5. Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination (114).
6. Miscellaneous Analyses (9).

II. Analyses of Milk sent on for Examination (113).

III. Analyses of Water sent on for Examination (109).

IV. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

V. Compilation of Analyses made at Amherst, Mass., of Fodder Articles, Fruits, Sugar-producing Plants, Dairy Products, etc.

I.

COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1892, to May 1, 1893.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.

1. General Introduction.

The sale of commercial manurial substances, compound and simple, has been quite extensive in our State. Fifty-one manufacturers and dealers have applied and received a license for the sale of their various brands in our State. Thirty-three of them are residents of other States.

Two hundred and three samples of licensed articles have been collected in all parts of the State by a duly authorized agent of the station. One hundred and eighty-five of them have been carefully analyzed at the chemical laboratory of the station, with the following results: no sample contained all three essential constituents above the highest guarantee; sixteen samples contained two of the essential constituents above the highest guarantee; sixty-two samples contained one of the essential elements above the highest guarantee; thirty-eight samples contained all three essential elements at the lowest guarantee; sixty-four samples contained two elements at the lowest guarantee; fifty-two samples contained one element at the lowest guarantee; no sample contained all three essential elements below the stated lowest guarantee; fifteen contained two elements below the stated

lowest guarantee; fifty-seven contained one element below the lowest stated guarantee. The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others.

The variations in the market price of the various prominent fertilizer constituents have been, on the whole, during the past year within the usual limits. Phosphoric acid in all forms has been offered at a somewhat lower cost towards the close of the year, while that of nitrogen in its leading forms has somewhat advanced.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate*, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not infrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does

not express *their respective agricultural value*, i. e., their crop-producing value; for the higher or lower market price of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information; namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, i. e., phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (i. e., the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric

acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals (1892).

	Cents per Pound.
Nitrogen in ammoniates,	17.5
Nitrogen in nitrates,	15.
Organic nitrogen in dry and fine ground fish, meat, blood,	16.
Organic nitrogen in cotton-seed meal and castor pomace,	15.
Organic nitrogen in fine-ground bone and tankage,	15.
Organic nitrogen in fine-ground medium bone and tankage,	12.
Organic nitrogen in medium bone and tankage,	9.5
Organic nitrogen in coarser bone and tankage,	7.5
Organic nitrogen in hair, horn shavings and coarse fish scraps,	7.
Phosphoric acid soluble in water,	7.5
Phosphoric acid soluble in ammonium citrate,	7.
Phosphoric acid in dry ground fish, fine bone and tankage,	7.
Phosphoric acid in fine medium bone and tankage,	5.5
Phosphoric acid in medium bone and tankage,	4.5
Phosphoric acid in coarse bone and tankage,	3.
Potash as high-grade sulphate, and in forms free from muriate or chlorides, ashes, etc.,	5.5
Potash as kainite,	4.5
Potash as muriate,	4.5

The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones, or other equally good forms, and not from leather, shoddy, hair, or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1891, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials*, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent.

in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as: —

Sulphate of ammonia,	Dry ground fish,
Nitrate of soda,	Azotin,
Muriate of potash,	Ammonite,
Sulphate of potash,	Castor pomace,
Dried blood,	Bone and tankage,
Dried ground meat,	Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application, at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. The Provisions of the Act are as follows:

[Chapter 296.]

An Act to regulate the sale of commercial fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Sect. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of

said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

SECT. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of

said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles, nitrogen, phosphoric acid and potassium oxide, guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they

desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates should be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances — as fodder articles, fertilizers, etc. — coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

3. List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in this State during the Past Year (May 1, 1892, to May 1, 1893), and the Brands licensed by Each.

Adams & Thomas, Springfield, Mass. : —
Adams's Market Bone Fertilizer.

Allen Fertilizer Company, Boston, Mass. : —
Allen Fertilizer.

Ames Fertilizer Company, Peabody, Mass. : —
Plymouth Rock Brand.

H. J. Barker & Bro., New York, N. Y. : —
"A. A." Ammoniated Superphosphate.
Standard U N X L D Fertilizer.
Special Corn Manure.
Special Grass Manure.
Special Potato Manure.
Special Tobacco Manure.
Fine Raw Ground Bone.

C. A. Bartlett, Worcester, Mass. : —
Animal Fertilizer.
Fine-ground Bone.

Bowker Fertilizer Company, Boston, Mass. : —
Stockbridge Manures.
Bowker's Ammoniated Bone Fertilizer.
Bowker's Sure Crop Bone Phosphate.
Bowker's Hill and Drill Phosphate.
Bowker's Farm and Garden Phosphate.
Bowker's Lawn and Garden Dressing.
Bowker's Fresh Ground Bone.
Bowker's Dry Ground Fish.
Bowker's Fish and Potash.
Gloucester Fish and Potash.
Breck's Lawn and Garden Dressing.
Dried Blood.
Dissolved Bone-black.
Nitrate of Soda.
Muriate of Potash.
Sulphate of Potash.

Bradley Fertilizer Company, Boston, Mass.: —
- X. L. Superphosphate of Lime.
- B. D. Sea-fowl Guano.
- Original Coe's Superphosphate.
- Farmer's New-method Fertilizer.
- English Lawn Dressing.
- High-grade Tobacco Manure.
- Bradley's Complete Manures: —
  - For Corn and Grain.
  - For Potatoes and Vegetables.
  - For Top-dressing Grass and Grain.
- Bradley's Potato Manure.
- Pure Fine-ground Bone.
- Fish and Potash.
- Dissolved Bone-black.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Muriate of Potash.
- Sulphate of Potash.

W. J. Brightman & Co., Tiverton, R. I.: —
- Dry Ground Fish.
- Fish and Potash.
- Superphosphate.

Bryant & Brett, New Bedford, Mass.: —
- Ground Bone.

Burgess & Roy, South Attleborough, Mass.: —
- Animal Fertilizer.

Joseph Church & Co., Tiverton, R. I.: —
- Pure Dry Ground Fish (A Brand).
- Special Fertilizer (B Brand).
- Standard Fertilizer (C Brand).
- Fish and Potash (D Brand).

Clark Cove Fertilizer Company, Boston, Mass.: —
- Bay State Fertilizer.
- Bay State Fertilizer, G. G.
- Great Planet Manure.
- King Philip Guano.
- Potato and Tobacco Fertilizer.
- Fish and Potash.

Cleveland Dryer Company, Boston, Mass.: —
- Cleveland Potato Phosphate.
- Cleveland Superphosphate.

Cleveland Linseed Oil Company, Worcester, Mass.: —
  Cleveland Steam-cooked Linseed Meal.

E. Frank Coe, New York, N. Y.: —
  Excelsior Gold Brand Guano.
  High-grade Ammoniated Bone Superphosphate.
  Fish Guano and Potash.
  Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y.: —
  New Rival Ammoniated Superphosphate.
  Ammoniated Bone Superphosphate.
  Ammoniated Practical Superphosphate.
  Vegetable Bone Superphosphate.
  Buffalo Superphosphate, No. 2.
  Wheat and Corn Phosphate.
  Potato, Hop and Tobacco Phosphate.
  Special Potato Manure.
  Ground Bone Meal.
  Pure Ground Bone.

Cumberland Bone Phosphate Company, Portland, Me.: —
  Cumberland Superphosphate.
  Potato Fertilizer.

L. B. Darling Fertilizer Company, Pawtucket, R. I.: —
  Darling's Animal Fertilizer.
  Darling's Fertilizer for Gardens and Lawns.
  Darling's Potato and Root Crop Manure.
  Darling's Tobacco Grower.
  Darling's Extra Bone Phosphate.
  Darling's Pure Dissolved Bone.
  Darling's Pure Fine Bone.

J. C. Dow & Co., Boston, Mass.: —
  Nitrogenous Superphosphate.
  Ground Bone Fertilizer.
  Ground Bone.

Forest City Wood Ash Company, London, Ont.: —
  Hardwood Ashes.

Wm. E. Fyfe & Co., Clinton, Mass.: —
  Canada Unleached Wood Ashes (Star Brand).

Great Eastern Fertilizer Company, Rutland, Vt.: —
  Great Eastern General, for Grass and Grain.
  Great Eastern Vegetable, Vine and Tobacco Fertilizers.
  Great Eastern General, Oats, Buckwheat and Seeding-down Phosphate.

Hargraves' Manufacturing Company, Fall River, Mass. : —
Ground Bone.

Edmund Hersey, Hingham, Mass. : —
Ground Bone.

Thos. Hersom & Co., New Bedford, Mass. : —
Meat and Bone.
Pure Fine-ground Bone.

Gilbert E. Holmes, New Worcester, Mass. : —
Pure Ground Bone.

John G. Jefferds, Worcester, Mass. : —
Animal Fertilizer.
Potato Manure.
Fine-ground Bone.

J. J. Joynt, St. Helens, Ont. : —
Canada Unleached Hardwood Ashes.

A. Lee & Co., Boston, Mass. : —
Lawrence Fertilizer.
Ground Bone.

Lowell Bone Fertilizer Company, Lowell, Mass. : —
Lowell Bone Fertilizer.

James E. McGovern, West Andover, Mass. : —
West Andover Market Bone Phosphate.
Ground Bone.

Mapes Formula and Peruvian Guano Company, New York, N. Y. : —
Mapes Superphosphates.
Mapes Special Crop Manures.
Peruvian Guanos.
Bone Manures.
Sulphate of Potash.

Monroe, DeForest & Co., Oswego, N. Y. : —
Hardwood Ashes.

National Fertilizer Company, Bridgeport, Conn. : —
Chittenden's Complete Fertilizer.
Chittenden's Universal Phosphate.
Chittenden's Fish and Potash.
Ground Bone.
Sulphate of Potash.

Pacific Guano Company, Boston, Mass. : —
Soluble Pacific Guano.
Special Potato Manure.

Prentiss, Brooks & Co., Holyoke, Mass. : —

Complete Manure.
Phosphate.
Dry Fish.
Dissolved Bone-black.
Nitrate of Soda.
Muriate of Potash.

Quinnipiac Fertilizer Company, Boston, Mass. : —

Quinnipiac Market-garden Manure.
Quinnipiac Corn Manure.
Quinnipiac Potato Manure.
Quinnipiac Potato and Tobacco Fertilizer.
Quinnipiac Havana and Seed-leaf Tobacco Fertilizer.
Quinnipiac Onion Manure.
Quinnipiac Phosphate.
Quinnipiac Pure Bone Meal.
Quinnipiac Dry Ground Fish.
Quinnipiac Fish and Potash (c. f. Brand).
Quinnipiac Fish and Potash (Plain Brand).
Muriate of Potash.
Sulphate of Potash.

Benjamin Randall, East Boston, Mass. : —

Market-garden Fertilizer.
Standard Ground Bone.

Read Fertilizer Company, Syracuse, N. Y. : —

H. G. Farmers' Friend.
Strawberry and Small Fruit Special.
Read's Standard Phosphate.
Bone, Fish and Potash (Fish and Potash).

John S. Reese & Co., Baltimore, Md. : —

New England Favorite.
May Flower.
Columbus, A.
Pilgrim.
Potato Special.
Fish and Potash.

Lucien Sanderson, New Haven, Conn. : —

Sanderson's Formula A.
Sanderson's Formula B.
Sanderson's High-grade Sulphate of Potash.
Sanderson's Regular Sulphate of Potash.

Edward H. Smith, Northborough, Mass. : —

Steamed Bone.

Springfield Fertilizer Company, Springfield, Mass. : —
H. L. Phelps' Complete Manures.

Springfield Provision Company, Brightwood, Mass. : —
Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass. : —
Standard Superphosphate.
Standard Fertilizer.
Standard Guano.
Potato and Tobacco Fertilizer.

F. C. Sturtevant, Hartford, Conn. : —
Tobacco and Sulphur Fertilizer.

J. A. Tucker & Co., Boston, Mass. : —
Original Bay State Bone Superphosphate.
Imperial Bone Superphosphate.

Whittemore Bros., Wayland, Mass. : —
Whittemore's Complete Manure.

Sanford Winter, Brockton, Mass. : —
Pure Ground Bone.

Leander Wilcox, Mystic, Conn. : —
Ammoniated Bone Phosphate.
High-grade Fish and Potash.
Potato, Onion and Tobacco Manure.
Dry Ground Fish.

William & Clark Fertilizer Company, Boston, Mass. : —
Ammoniated Bone Superphosphate.
Universal Ammoniated Dissolved Bone.
High-grade Special.
Potato and Tobacco Manure.
Fine Wrapper Tobacco Grower.
Potato Phosphate.
Corn Phosphate.
Pure Bone Meal.
Dry Ground Fish.
Fish and Potash.
Nitrate of Soda.
Muriate of Potash.
Sulphate of Potash.

4. Analyses of Licensed Fertilizers collected during 1892 in the General Markets by the Agent of the Massachusetts Agricultural Experiment Station.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
2	Special Tobacco Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
12	Dry Ground Fish,	Williams & Clark, Boston, Mass.,	Northampton.
34	Jefferds' Potato Manure,	John G. Jefferds, Worcester, Mass.,	Worcester.
40	Dry Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
50	Fine-ground Dry Fish,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
58	Jefferds' Potato Manure,	John G. Jefferds, Worcester, Mass.,	Hadley.
59	Jefferds' Animal Fertilizer,	John G. Jefferds, Worcester, Mass.,	Hadley.
87	Crocker's Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
90	Pacific Guano Company's Special Potato Manure,	W. D. Stewart, Boston, Mass.,	Pittsfield.
97	Crocker's Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
108	Bay State Fertilizer,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
	Chemicals.		
32	Muriate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Worcester.
33	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Worcester.
64	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
65	Muriate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
75	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
119	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	New Bedford.
146	Nitrate of Soda,	Williams & Clark, Boston, Mass.,	Greenfield.
148	Muriate of Potash,	Williams & Clark, Boston, Mass.,	Greenfield.
	Bones.		
7	H. J. Baker & Bro.'s Raw Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
24	H. J. Baker & Bro.'s Raw Ground Bone,	H. J. Baker & Bro , New York, N. Y.,	Springfield.
35	Jefferds' Fine-ground Bone,	John G. Jefferds, Worcester, Mass.,	Worcester.
37	Bartlett's Fine-ground Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
60	Steamed Bone,	E. H. Smith, Northborough, Mass.,	Amherst.
161	Darling's Ground Bone,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Fitchburg.
	Wood Ashes.		
144	Canada Unleached Hardwood Ashes,	Monroe, DeForest & Co., Oswego, N. Y.,	South Deerfield.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds. Found.	Nitrogen Guaranteed.	Phosphoric Acid in One Hundred Pounds. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in One Hundred Pounds. Found.	Potassium Oxide Guaranteed.
	Compound Fertilizers.												
2	Special Tobacco Manure,	8.52	4.36	4.53	5.12	.05	.20	5.37	–	5.17	4	9.56	10*
12	Dry Ground Fish,	7.30	7.96	7.41—9.06	.18	3.56	4.09	7.83	7—8	3.74	–	–	–
34, 58	Jefferds' Potato Manure,	7.74	2.48	2.47—3.30	4.81	5.68	3.74	14.23	15—17	10.49	10—12	6.09	5—6*
40	Dry Fish Guano,	10.34	8.27	7.41—9.06	.82	3.30	3.17	7.29	7—9	4.12	–	–	–
50	Fine-ground Dry Fish,	10.12	8.64	6.59—8.24	.61	3.97	2.61	7.19	7—8	4.58	–	–	–
59	Jefferds' Animal Fertilizer,	11.30	2.95	2.47—3.30	4.38	14.17	4.63	23.18	16—18	18.55	11—13	3.16	2.50—3.50*
87, 97	Crocker's Wheat and Corn Phosphate,	13.22	2.34	2—3	6.35	4.31	1.64	12.60	11—15	10.66	10—13	2.95	1.80—2.70*
90	Special Potato Manure,	13.34	2.67	2.47—3.30	4.35	1.28	2.81	8.44	7—10	5.63	5—7	5.12	5—6
108	Bay State Fertilizer,	13.03	2.68	2.47—3.30	7.57	2.51	2.61	12.69	10—14	10.08	9—12	2.26	2—3*
	Chemicals.												
32, 65	Muriate of Potash,	1.94	–	–	–	–	–	–	–	–	–	50.65	50.34—53.70
33, 64	Nitrate of Soda,	1.10	15.44	15.65—16.14	–	–	–	–	–	–	–	–	–
75	Dissolved Bone-black,	13.73	–	–	16.67	.30	.23	17.22	–	16.97	16—17	–	–
119	Muriate of Potash,	1.26	–	–	–	–	–	–	–	–	–	50.40	48—55
146	Nitrate of Soda,	1.02	15.52	15.65—16.14	–	–	–	–	–	–	–	–	–
148	Muriate of Potash,	1.04	–	–	–	–	–	–	–	–	–	51.10	50.54—53.70
	Bones.												
7, 24	Fine Raw Ground Bone,	8.53	3.77	3.30—3.91	.19	7.27	17.97	25.43	22—26	7.46	–		
35	Fine-ground Bone,	9.00	1.51	2.47—3.30	.31	13.02	16.58	29.91	27—30	13.33	–		
37	Fine-ground Bone,	3.95	3.60	2.39	.82	10.74	13.41	24.97	27.35	11.56	–		
60	Steamed Bone,	5.24	4.00	4.02	31	8.44	14.38	23.13	23.50	8.75	7.69		
161	Fine-ground Bone,	3.40	2.84	2.47—3.30	.26	10.69	14.25	25.20	24—26	10.95	–		
	Wood Ashes.											Potassium Oxide. Found.	Potassium Oxide. Guaranteed.
144	Canada Unleached Hardwood Ashes,	11.27	–	–	–	–	–	1.30	1—2.50	–	–	5.42	4.50—7

Mechanical Analysis (Bones).

Laboratory Number.	Fine.	Fine Med.	Med.	Coarse Med.
7, 24	42.84	56.30	.70	.16
35	64.20	31.05	4.75	–
37	55.92	33.00	10.01	1.07
60	44.03	44.64	11.33	–
161	75.12	16.52	7.36	–

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
56	Darling's Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Sunderland.
179	High-grade Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Hadley.
141	Tobacco Manure (Wrapper Brand),	Mapes' Formula and Peruvian Guano Company, New York, N. Y.,	South Deerfield.
188	Blood, Meat and Bone,	Springfield Provision Company, Brightwood, Mass.,	Brightwood.
197	Potato, Onion and Tobacco Manure,	Leander Wilcox, Mystic, Conn.,	Holyoke.
101	Animal Fertilizer (Darling's),	L. B. Darling Company, Pawtucket, R. I.,	Worcester.
85	High-grade Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Lee.
94	Great Eastern Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Pittsfield.
81	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
100	Onion Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	South Deerfield.
151	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Greenfield.
48	Cumberland Superphosphate,	Cumberland Bone Company, Portland, Me.,	Sunderland.
129	Ammoniated Practical Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
45	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
26	Fish and Potash, D Brand,	Joseph Church & Co., Tiverton, R. I.,	Springfield.
153	May Flower,	John S. Reese & Co. Baltimore, Md.,	Greenfield.
18	Bradley's X. L. Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
106	Fish and Potash, D Brand,	Joseph Church & Co., Tiverton, R. I.,	Taunton.
103	Cleveland Potato Phosphate,	Cleveland Dryer Company, Cleveland, Ohio.,	So. Framingham.
42	Bradley's X. L. Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
164	Superphosphate (Cumberland),	Cumberland Bone Company, Portland, Me.,	Lowell.
109	New England Favorite,	J. S. Reese & Co., Baltimore, Md.,	Dighton.
	Bones.		
86	Pure Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lee.
128	Pure Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
120	Pure Fine-ground Bone,	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.
167	Pure Fine-ground Bone,	Thos. Hersom & Co., New Bedford, Mass.,	New Bedford.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds. Found.	Nitrogen in One Hundred Pounds. Guaranteed.	Phosphoric Acid in One Hundred Pounds. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in One Hundred Pounds. Found.	Potassium Oxide in One Hundred Pounds. Guaranteed.
	Compound Fertilizers.												
56, 101	Darling's Animal Fertilizer,	18.27	3.40	3.30—4.90	4.55	2.62	4.50	11.67	10—12	7.17	-	4.49	4—6
179, 85	High-grade Ammoniated Bone Superphosphate,	11.37	2.34	2—2.50	7.23	1.41	2.43	11.07	11—13	8.64	9—12	2.24	2*
141	Tobacco Manure (Wrapper Brand),	8.57	6.02	6.18	.45	2.43	3.26	6.14	4.50	2.88	-	11.69	10.50*
188	Blood, Meat and Bone,	8.76	7.18	7.76	51	4.61	4.86	9.98	10.66	5.12	-	-	-
197	Potato, Onion and Tobacco Manure,	7.05	3.91	3.25—4.25	6.65	1.22	2.94	10.81	8—9	7.87	7—8	5.72	6—7
94	Great Eastern Vegetable, Vine and Tobacco Fertilizer,	13.90	2.14	2.06—2.88	7.04	1.15	1.34	9.53	9—15	8.19	8—12	6.10	6—8
81, 45	Potato Manure,	13.72	3.18	2.47—3.30	4.09	1.80	2.43	8.32	7—11	5.89	6—9	4.37	5—6*
100	Onion Manure,	10.52	3.65	3.30—4.12	6.22	5.22	1.25	12.69	9—13	11.44	8—11	6.50	7—8*
151	Standard Fertilizer,	10.46	2.11	2—3	7.06	2.21	2.81	12.08	10—15	9.27	8—12	2.16	2—3
48, 164	Cumberland Superphosphate,	11.64	2.20	2.06—2.88	8.39	1.28	2.56	12.23	10—12	9.67	8—10	2.28	2—3*
129	Ammoniated Practical Superphosphate,	11.62	1.27	.82—1.64	5.99	3.28	1.48	10.75	9—12	9.27	8—10	1.98	1—2*
26, 106	Fish and Potash, D Brand,	13.54	2.68	2.47—3.30	4.66	2.00	1.48	8.14	7.50—8.50	6.66	-	2.25	2—3
153	May Flower,	11.86	1.91	1.80—2.50	3.07	6.44	1.18	10.69	10—13	9.51	8.50—10	2.49	2.25—3
18, 42	Bradley's X. L. Superphosphate of Lime,	13.48	2.97	2.50—3.25	6.91	4.86	1.48	13.25	11—13	11.77	9—11	2.19	2—3*
103	Cleveland Potato Phosphate,	7.57	2.52	2.05—2.85	7.42	2.10	1.33	10.85	10—13	9.52	8—10	4.01	3—4*
109	New England Favorite,	17.54	2.58	2.47—3.30	3.84	7.16	.51	11.51	11—14	11.00	9—12	2.37	2—3

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Mechanical Analysis. Fine.	Fine Med.	Med.	Coarse Med.
	Bones.														
86, 128	Pure Ground Bone,	7.48	3.51	2—3.70	.24	7.05	16.76	24.05	25.00	7.29	-	26.20	25.78	39.39	8.63
120, 167	Pure Fine-ground Bone,	4.27	1.68	2.08	.26	10.29	20.09	30.64	29.42	10.55	13.62	59.67	22.71	15.00	2.62

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at—
	Compound Fertilizers.		
8	Ammoniated Bone Superphosphate (Americus Brand),	Williams & Clark Fertilizer Company, Boston, Mass.,	Northampton.
16	Bradley's High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
23	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
28	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Springfield.
31	Bowker's Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Worcester.
41	High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
43	Dry Ground Fish,	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
67	High-grade Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
76	Complete Manure for Corn,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
83	Ammoniated Bone Superphosphate (Americus Brand),	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
96	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
107	Clark's Cove Fish and Potash,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
112	Columbus "A" Manure,	J. S. Reese & Co., Baltimore, Md.,	Dighton.
115	Market-garden Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Fall River.
117	Potato, Tobacco and Hop Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fall River.
124	Plymouth Rock Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Amherst.
125	Dow's Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Amherst.
133	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
136	Potato, Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
166	Lowell Bone Fertilizer,	J. M. Butman, Chelmsford, Mass.,	Chelmsford.
180	Red Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Hadley.
193	Market-garden Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Northampton.
195	Columbus "A" Manure,	J. S. Reese & Co., Baltimore, Md.,	Springfield.
198	Complete Manure for Corn,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
	Bones.		
52	Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
113	Ground Bone,	Hargraves' Manufacturing Company, Fall River, Mass.,	Fall River.
116	Ground Bone,	Hargraves' Manufacturing Company, Fall River, Mass.,	Fall River.
121	Pure Ground Bone,	S. Winter, Brockton, Mass.,	Brockton.
138	Pure Ground Bone,	S. Winter, Brockton, Mass.,	Amherst.
169	Fine-ground Bone,	Bryant & Brett, New Bedford, Mass.,	New Bedford.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
8, 83	Ammoniated Bone Superphosphate (Americus Brand),	11.44	2.78	2.47—3.80	6.14	2.92	2.35	11.41	10—13	9.06	9—11	1.53	2—3*
16, 41	Bradley's High-grade Tobacco Manure,	7.32	5.92	5.77—6.59	2.25	1.02	3.28	6.55	4—5	3.27	-	10.31	10.80*
23, 31	Bowker's Lawn and Garden Dressing,	14.46	4.08	4.12—4.94	5.99	.05	5.22	11.26	6—8	6.04	5—6	5.03	5—6*
28	Tobacco and Sulphur Lawn Fertilizer,	12.72	1.94	1.96	trace	.25	.26	.51	.75	.25	-	8.34	7.66
43	Dry Ground Fish,	6.38	8.72	7.41—9.06	.77	3.48	2.30	6.55	7—9	4.25	-	-	-
67	High-grade Fish and Potash,	19.44	3.66	3.25—4.25	2.97	1.43	2.25	6.65	6—7	4.40	5—6	4.93	4—5
76, 198	Complete Manure for Corn,	13.92	3.36	3.30—4.12	4.75	.78	1.25	6.78	8—10	5.53	4—6	5.85	6—7
96, 133	Special Potato Manure,	11.95	3.90	3.70—4.50	5.68	1.48	2.51	9.67	9—11	7.16	8—9	5.45	5.40—6.40*
107	Clark's Cove Fish and Potash,	16.34	3.44	2.47—4.12	3.38	2.20	1.89	7.47	7—9	5.58	6—8	2.73	3—5*
112, 195	Columbus "A" Manure,	15.73	3.44	3.29—4.11	2.66	5.12	.77	8.55	8—11	7.78	7—9	9.06	9.50—11
115, 193	Market-garden Manure,	12.94	3.82	3.30—4.12	6.55	.87	2.66	10.08	9—13	7.42	8—11	6.98	7—8*
117, 136	Potato, Tobacco and Hop Phosphate,	15.01	2.56	2—3	7.42	7.17	1.41	16.00	11—14	14.59	10—12	3.87	3.25—4.30*
124	Plymouth Rock Fertilizer,	19.28	2.52	2.47—3.30	5.31	5.92	.19	11.42	9—13	11.23	8—10	3.52	3—4
125	Dow's Nitrogenous Superphosphate,	20.82	2.32	2.03—2.88	3.71	5.46	1.04	10.21	8—10	9.17	-	2.18	1.90—2.53
166	Lowell Bone Fertilizer,	13.97	2.48	2—2.50	5.76	6.01	.13	11.90	9—16.5	11.77	7—13.5	2.88	2—3.50
180	Red Brand Excelsior Guano,	12.82	3.14	3.50—4	7.16	1.86	1.02	10.04	10—14	9.02	9—12	6.47	6*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Mechanical Analysis. Fine.	Fine Med.	Med.	Coarse Med.
	Bones.														
52	Fresh Ground Bone,	4.89	3.40	2.47—3.30	1.05	6.62	10.75	18.42	18—22	7.67	5—7	39.96	29.04	24.50	6.50
113, 116	Ground Bone,	12.05	2.80	2.50—2.80	.32	11.45	13.87	25.66	25—27	11.77	-	21.28	37.86	18.48	22.38
121, 138	Pure Ground Bone,	5.82	3.32	3.66	.20	11.67	10.90	22.77	22.85	11.87	9.55	59.61	20.75	8.70	10.94
169	Pure Fine-ground Bone,	6.96	2.50	2.50	.10	7.06	18.40	25.56	25.56	7.16	7.16	17.69	20.74	19.90	41.67

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
4	Complete Grass Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
17	Bradley's Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
36	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Worcester.
54	Ammoniated Bone Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
57	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Sunderland.
74	Phosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
82	Cleveland Steam-cooked Linseed Meal,	Cleveland Linseed Oil Company, Cleveland, Ohio,	Springfield.
91	Soluble Pacific Guano,	W. D. Stewart & Co., Boston, Mass. (Agent),	Pittsfield.
92	Chittenden's Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Pittsfield.
102	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
110	Dry Ground Fish,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
118	Chittenden's Fish and Potash,	National Fertilizer Company, Bridgeport, Conn.,	New Bedford.
122	Whittemore's Complete Manure,	Whittemore Bros., Wayland, Mass.,	Wayland.
123	Animal Fertilizer,	Burgess & Roy, South Attleborough, Mass.,	Amherst.
130	Buffalo Superphosphate, No. 2,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
156	Standard Fertilizer,	Read Fertilizer Company, Syracuse, N. Y.,	Gardner.
157	Strawberry Special,	Read Fertilizer Company, Syracuse, N. Y.,	Gardner.
172	Lawrence Fertilizer,	A. Lee & Co., Boston, Mass.,	Lawrence.
173	West Andover Market Bone Phosphate,	J. E. McGovern, Lawrence, Mass.,	Lawrence.
183	Chittenden's Fish and Potash,	National Fertilizer Company, Bridgeport, Conn ,	Hadley.
199	Garden and Lawn Dressing,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Amherst.
	Chemicals.		
72	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
73	Nitrate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
140	Sulphate of Potash,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	South Deerfield.
147	Sulphate of Potash,	Williams & Clark, Boston, Mass.,	Greenfield.
175	Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass ,	Amherst.
176	Sulphate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
177	Muriate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
178	Sulphate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
184	Sulphate of Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
	Wood Ashes.		
98	Canada Unleached Hardwood Ashes,	J. J. Joynt, St. Helens, Ont.,	South Deerfield.
139	Wood Ashes,	Forest City Wood Ash Company, London, Ont.,	South Deerfield.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4	Complete Grass Manure,	16.18	3.50	3.71	4.20	1.43	.23	5.86	-	5.63	5	8.17	7.50
17	Bradley's Com. Manure for Potatoes and Veg.,	10.20	3.98	3.75—4.50	6.91	1.93	1.02	9.86	9—12	8.84	8—11	7.69	6—7*
36	Animal Fertilizer,	6.42	3.72	3.30—4.12	3.07	3.57	5.76	12.40	16—18	6.64	-	7.73	7—8
54	Ammoniated Bone Phosphate,	12.42	1.88	1.65—2.47	5.65	3.09	2.39	11.13	10—12	8.74	8—10	2.13	2—3
57 / 102	Potato and Root Crop Manure,	13.55	2.36	2.88—4.12	4.09	3.33	2.56	9.98	10—12	7.42	-	7.66	7—9
74	Phosphate,	11.94	2.70	2.47—3.30	6.58	1.84	2.43	10.85	8—10	8.42	-	3.04	3—4
82	Cleveland Steam-cooked Linseed Meal,	10.85	5.95	5.80—6.20	-	-	-	2.00	1.998—2.20	-	-	1.36	1.30—1.50
91	Soluble Pacific Guano,	16.82	2.40	2.25—4.00	6.66	2.93	2.05	11.64	10.50—16	9.59	8.50—12	3.15	2—3.50*
92	Chittenden's Ammoniated Bone Superphos.,	10.72	2.44	1.65—2.47	7.83	2.10	2.15	12.08	9—11	9.93	7—9	3.27	2—4
110	Dry Ground Fish,	7.82	7.16	7.41—9.06	.97	2.67	3.58	7.22	7—9	3.64	-	-	-
118 / 183	Chittenden's Fish and Potash,	6.26	3.00	3.30—4.12	1.57	2.05	5.28	8.90	6—8	3.62	-	6.20	5—6
122	Whittemore's Complete Manure,	11.76	3.62	2.47—3.30	6.19	5.81	3.88	15.88	12—14	12.00	8—12	2.79	3—4
123	Animal Fertilizer,	4.00	4.20	2.47—4.12	.20	4.66	12.64	17.50	12—15	4.86	10—12	4.99	3—5
130	Buffalo Superphosphate, No. 2,	18.10	-	-	10.39	1.16	1.60	13.15	12—15	11.55	11—13	2.62	1.35—2*
156	Standard Fertilizer,	12.60	1.08	.82—1.65	5.42	2.25	.26	7.93	10—12	7.67	8—10	4.49	4—6*
157	Strawberry Special,	16.37	3.10	3.30—4.94	3.45	2.30	1.15	6.90	6—8	5.75	5—6	7.43	6—8*
172	Lawrence Fertilizer,	9.88	2.30	2.06—2.88	3.88	7.98	2.16	14.02	12	11.86	-	4.24	2—3
173	West Andover Market Bone Phosphate,	11.50	1.62	2.50—3.50	4.35	8.66	4.73	17.74	13—15	13.01	6—8	1.50	4—6
199	Garden and Lawn Dressing,	7.06	3.82	4—6	4.66	1.99	3.79	10.44	10—12	6.65	-	6.49	5—6
	Chemicals.												
72	Muriate of Potash,	.60	-	-	-	-	-	-	-	-	-	51.65	50.54—53.70
73	Nitrate of Soda,	1.72	13.88	14.82—15.52	-	-	-	-	-	-	-	-	-
140	Sulphate of Potash,	8.50	-	-	-	-	-	-	-	-	-	26.92	25.94—28.10*
147	Sulphate of Potash,	4.50	-	-	-	-	-	-	-	-	-	24.90	25.94—27.02*
175	Sulphate of Potash,	.65	-	-	-	-	-	-	-	-	-	49.60	48—52*
176	Sulphate of Potash,	3.42	-	-	-	-	-	-	-	-	-	26.35	25.94—27.02*
177	Muriate of Potash,	1.77	-	-	-	-	-	-	-	-	-	51.36	50.54—53.70
178	Sulphate of Potash,	4.82	-	-	-	-	-	-	-	-	-	25.78	25.94—27.02*
184	Sulphate of Potash,	4.53	-	-	-	-	-	-	-	-	-	24.15	25.94—27.02*
	Wood Ashes.												
98	Canada Unleached Hardwood Ashes,	13.10	-	-	-	-	-	1.77	-	-	-	4.72	5—7
139	Wood Ashes,	15.75	-	-	-	-	-	1.33	1.50—2.50	-	-	5.44	4.50—8.50

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
1	Pelican Bone Standard Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
5	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
10	Potato Phosphate,	Williams & Clark, Boston, Mass.,	Northampton.
15	Mapes' Manure for Potatoes,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Northampton.
27	Pure Dry Fish A Brand,	Joseph Church & Co., Tiverton, R. I.,	Springfield.
30	Bradley's Complete Manure for Top-dressing Grass, etc.,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
39	Fish and Potash, Brand B,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
44	Fish and Potash (Crossed Fish Brand),	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
46	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
47	Potato and Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	North Amherst.
61	Dried Blood,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
62	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
68	Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
79	Quinnipiac Phosphate,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
80	Fish and Potash (Crossed Fish Brand),	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
84	Potato Phosphate,	Williams & Clark, Boston, Mass.,	Springfield.
89	Pelican Bone Standard Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
104	Cleveland Superphosphate,	Cleveland Dryer Company, Cleveland, Ohio,	So. Framingham.
111	Great Planet A Manure, Potatoes, Onions, etc.,	Clark's Cove Company, Boston, Mass.,	Dighton.
114	Mapes' Manure for Potatoes,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Fall River.
127	Ground Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Amherst.
132	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
154	Fish and Potash,	John S. Reese & Co., Baltimore, Md.,	Greenfield.
181	High-grade Fish and Potash,	E. Frank Coe, New York, N. Y.,	Hadley.
189	The H. L. Phelps Fish and Potash,	Springfield Fertilizer Company, Springfield, Mass.,	Springfield.
190	The H. L. Phelps Complete Manure for Potatoes and Vegetables,	Springfield Fertilizer Company, Springfield, Mass.,	Springfield.
192	Adams Market Bone Phosphate,	Adams & Thomas, Springfield, Mass.,	Springfield.
200	Tobacco Grower,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Amherst.
202	Dissolved Bone,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Amherst.
203	Potato Special,	J. S. Reese & Co., Baltimore, Md.,	Springfield.
	Bones.		
126	Ground Bone,	John C. Dow & Co., Boston, Mass.,	Amherst.
131	Ground Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
158	Ground Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
168	Meat and Bone,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
171	Pure Ground Bone,	William Lavery, Amesbury, Mass.,	Amesbury.
174	Ground Bone,	J. E. McGovern, Lawrence, Mass.,	West Andover.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds. Found.	Nitrogen Guaranteed.	Phosphoric Acid in One Hundred Pounds. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in One Hundred Pounds. Found.	Potassium Oxide Guaranteed.
	Compound Fertilizers.												
1, 89	Pelican Bone Standard Fertilizer,	16.60	2.04	1.85—2.27	6.02	3.20	1.02	10.24	-	9.22	8—10	2.94	2.25—3
5	Potato Manure,	9.70	3.98	3.30	3.68	2.13	.92	6.73	-	5.81	5.75	9.97	10
10, 84	Potato Phosphate,	15.55	2.92	2.47—3.30	5.65	1.08	2.05	8.78	7—11	6.73	6—9	5.99	5—6*
15, 114	Mapes' Manure for Potatoes,	11.62	3.46	3.71—4.12	7.04	1.26	.52	8.82	8—10	8.30	8	8.16	6—8*
27	Pure Dry Fish,	9.25	8.66	8.24—9.89	.64	3.25	4.91	8.80	6.87-11.45	3.89	-	-	-
30	Bradley's Complete Manure for Grass,	7.75	4.80	4.95—5.78	1.40	3.58	1.80	6.78	6—8	4.98	5—7	2.88	2.6—3.5*
39	Fish and Potash,	15.85	2.84	2.48—3.50	5.12	1.90	1.16	8.18	7.5—9.5	7.02	6—8	2.14	2—3*
44, 80	Fish and Potash (Crossed Fish Brand),	15.06	3.46	3.30—4.12	3.86	1.65	2.51	8.02	5—8	5.51	3—5	3.49	3—5*
46	Corn Manure,	17.72	2.62	2.06—2.88	6.01	4.35	1.92	12.28	10—14	10.36	9—12	1.63	1.5—2.5*
47	Potato and Tobacco Manure,	14.63	2.66	2.06—2.88	5.67	1.74	2.62	10.03	9—13	8.41	8—11	3.26	3—4*
61	Dried Blood,	9.12	8.96	8.24—9.89	-	-	-	-	-	-	-	-	-
62	Dissolved Bone-black,	16.29	-	-	14.33	.96	.06	15 35	-	15.29	15—18	-	-
68	Dry Ground Fish Guano,	10.02	9.02	8—10	.64	3.71	3.20	7.55	-	4.35	4—6	-	-
79	Quinnipiac Phosphate,	11.55	2.44	2.47—3.30	5.17	5.70	3.20	14.07	10—14	10.87	9—12	2.31	2—3*
104	Cleveland Superphosphate,	12.23	2.52	2.05—2.85	4.81	4.45	2.00	11.26	11—14	9.26	9—11	2.44	2—3*
111	Great Planet A Manure, Potatoes, Onions, etc.,	12.27	3.40	3.30—4.12	6.02	.76	2.18	8.96	9—13	6.78	8—11.5	7.23	7—8*
127	Ground Bone Fertilizer,	8.25	2.00	2.06—2.47	.31	7.20	12.68	20.19	18—22	7.51	-	3.17	3—3.5
132	New Rival Ammoniated Superphosphate,	15.77	2.30	1.2—2	8.44	2.18	1.15	11.77	11—15	10.62	10—12	1.74	1.6—2.7*
154	Fish and Potash,	12.45	2.68	2.47—4.11	4.99	2.56	1.92	9.47	7—10	7.55	6.5—8	4.27	3—5
181	High-grade Fish and Potash,	16.01	3.34	3.3—4.1	2.60	2.91	2.51	8.02	7—11	5.51	6—9	2.68	2.75*
189	The H. L. Phelps Fish and Potash,	9.45	3.72	3.30—4.12	1.80	2.04	2.30	6.14	4—7	3.84	-	4.44	4—6
190	The H. L. Phelps Complete Man. for Pot. & Veg.,	8.12	3.32	4.12—4.94	3.22	2.25	1.18	6.65	6—8	5.47	5—6	7.69	8—10
192	Adams Market Bone Phosphate,	6.78	2.86	2.5—3.5	.47	5.47	10.00	15.94	8—10	5.94	6—8	4.96	3—5
200	Tobacco Grower,	8.27	4.44	4.94—5.77	2.68	2.94	2.18	7.80	10—12	5.62	-	11.34	10—12
202	Dissolved Bone,	14.10	2.32	1.65—2.47	9.08	6.27	1.66	17.01	21—23	14.97	14—16	-	-
203	Potato Special,	15.22	3.10	2.97—3.80	2.30	5.38	.64	8.32	-	7.68	6—8	8.04	7.5—9.5

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Mechanical Analysis. Fine.	Fine Med.	Med.	Coarse Med.
	Bones.														
126	Ground Bone,	3.55	2.08	1.65—2.47	.13	7.04	18.93	26.10	24—26	7.17	-	54.36	45.42	.22	-
131, 158	Ground Bone Meal,	6.75	1.98	2—3	-	10.44	19.18	29.62	25—28	10.44	-	85.95	10.13	3.92	-
168	Meat and Bone,	4.75	3.90	4.24	.26	6.39	13.69	20.34	19.52	6.65	6.73	52.74	33.14	11.70	2.42
171	Pure Ground Bone,	9.47	2.90	-	-	3.43	12.15	15.58	-	3.43	-	47.42	30.41	18.37	3.80
174	Ground Bone,	11.70	2.60	-	-	11.65	13.69	25.34	-	11.65	-	52.10	24.24	17.58	6.08

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
6	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
11	Fish and Potash,	Williams & Clark, Boston, Mass.,	Northampton.
14	Mapes' Grass and Grain, Spring Top Dressing,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Northampton.
20	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables,	National Fertilizer Company, Bridgeport, Conn.,	Northampton.
22	Stockbridge Special Potato Manure,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
25	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
29	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass ,	Worcester.
38	Bradley's Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
53	Stockbridge Manure for Potatoes and Vegetables,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
55	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Sunderland.
69	Williams & Clark's Corn Phosphate (Americus Brand),	Williams & Clark, Boston, Mass.,	Amherst.
70	Ammoniated Bone Phosphate, No. 1,	Leander Wilcox, Mystic, Conn.,	Amherst.
77	Ground Scrap,	Ellsworth, Tuthill & Co.,	Holyoke.
95	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables,	National Fertilizer Company, Bridgeport, Conn.,	Pittsfield.
99	Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	South Deerfield.
135	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
137	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
143	Manure for Light Soils,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	South Deerfield.
145	Gloucester Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
149	Fine Wrapper Tobacco Grower,	Williams & Clark, Boston, Mass.,	Greenfield.
152	Complete Manure for Corn and Grain,	Bradley Fertilizer Company, Boston, Mass.,	Greenfield.
155	Samson Fertilizer,	Read Fertilizer Company, Syracuse, N. Y.,	Gardner.
159	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
162	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
163	Farmer's New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
165	Cumberland Potato Fertilizer,	Cumberland Bone Phosphate Company, Portland, Me.,	Lowell.
182	Ground Fish,	E. Frank Coe, New York, N. Y.,	Hadley.
185	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
186	Farm and Garden Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
187	Square Brand Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
194	Havana and Seed-leaf Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Northampton.
201	Extra Bone Phosphate,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Amherst.

4. Analyses of Licensed Fertilizers, etc. — *Concluded.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds. Found.	Nitrogen in One Hundred Pounds. Guaranteed.	Phosphoric Acid in One Hundred Pounds. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potassium Oxide in One Hundred Pounds. Found.	Potassium Oxide in One Hundred Pounds. Guaranteed.
	Compound Fertilizers.												
6, 25	A. A. Ammoniated Superphosphate,	6.42	3.08	2.47—3.30	7.93	3.12	-	11.05	11—15	11.05	10—12	3.66	2—3
11	Fish and Potash,	8.92	3.46	3.30—4.12	3.07	2.22	2.51	7.80	6—8	5.29	3—5	3.48	3—5*
14	Mapes' Grass and Grain Spring Top Dressing,	11.27	5.00	4.12—5.77	5.88	1.93	1.15	8.96	7—9	7.81	5—7	6.68	5—7
20, 95, 185	Chittenden's Complete Fertilizer for Potatoes, Roots and Vegetables,	8.52	3.98	3.30—4.12	3.71	5.12	2.56	11.39	8—10	8.83	6—8	6.66	6—8
22	Stockbridge Special Potato Manure,	11.15	3.70	3.25—4.25	4.81	3.74	2.66	11.21	8—10	8.55	7—8	6.68	5—6
29, 55	Hill and Drill Phosphate,	14.10	2.72	2.50—3.25	5.88	5.12	1.92	12.92	12—14	11.00	8—10	1.95	2—3
38	Bradley's Potato Manure,	13.49	3.00	2.50—3.25	2.97	3.32	3.28	9.57	8—11	6.29	6—8	5.41	5—6*
53	Stockbridge Manure for Potatoes and Vegetables,	10.85	3.36	3.25—4.25	5.09	2.82	2.58	10.49	8—10	7.91	7—8	6.93	5—6
69	Williams & Clark's Corn Phosphate,	14.47	2.48	2.06—2.88	6.52	2.95	1.92	11.39	10.50—14	9.47	9—12	2.13	1.50—2.50*
70	Ammoniated Bone Phosphate, No. 1,	15.95	3.27	2.50—3.50	3.20	2.55	2.05	7.80	7—8	5.75	6—7	5.25	5—6
77	Ground Scrap,	9.45	9.21	8.24	.13	3.58	3.20	6.91	6	3.71	-	-	-
99	Tobacco Fertilizer,	7.00	6.53	5.77	1.66	3.07	1.92	6.65	9—13	4.73	5	10.83	10*
135	Ammoniated Bone Superphosphate,	14.15	3.71	2.90—3.70	9.59	1.66	.90	12.15	11—14	11.25	10—12	1.93	1—2*
137, 159	Vegetable Bone Superphosphate,	13.65	5.24	5—6	5.38	1.28	1.02	7.68	7—9	6.66	6—7	8.48	6—8*
143	Manure for Light Soils,	9.97	4.90	4.94—6.59	4.96	2.54	2.17	9.67	8—10	7.50	6—8	6.77	6—8
145	Gloucester Fish and Potash,	11.26	.94	.82—1.65	8.98	1.21	4.96	15.15	9—11	10.19	6—9	3.71	1—2*
149	Fine Wrapper Tobacco Grower,	7.45	5.54	5.77—6.59	1.43	2.48	2.05	5.96	6—9	3.91	5—7	11.97	10—12*
152	Complete Manure for Corn and Grain,	12.82	3.12	2.89—3.91	6.27	3.06	1.54	10.87	9—12	9.33	8—10	4.02	3—4*
155	Samson Fertilizer,	15.45	2.42	2.47—3.30	6.66	1.79	.51	8.96	9—12	8.45	8—10	6.20	5—6*
162	English Lawn Dressing,	8.72	5.35	4.95—5.70	2.04	3.34	1.02	6.40	6—9	5.38	5—7	4.63	2.50—3.50*
163	Farmers' New Method Fertilizer,	14.07	1.30	.82—1.65	5.62	2.96	2.30	10.88	10—12	8.58	8—10	3.80	2.16—3.24*
165	Cumberland Potato Fertilizer,	13.05	2.52	2.06—2.88	7.42	2.82	1.15	11.39	11—13	10.24	9—11	4.80	3—4*
182	Ground Fish,	10.57	8.32	8.24—9.06	.51	3.20	3.33	7.04	-	3.71	-	-	-
186	Farm and Garden Phosphate,	13.42	1.93	2—3	5.01	3.63	1.59	10.23	10—12	8.64	8—10	2.73	2—3
187	Square Brand Fish and Potash,	3.85	1.92	2.25—3.25	5.04	1.64	5.68	12.36	8—10	6.68	-	4.83	4—6
194	Havana and Seed-leaf Tobacco Fertilizer,	7.17	5.98	5.77—6.59	4.86	.64	.77	6.27	6—9	5.50	5—7	11.87	10—12*
201	Extra Bone Phosphate,	14.75	2.76	2.47—3.30	4.73	2.94	4.61	12.28	10—12	7.67	7—9	4.46	3—5

* Sulphate of potash, the source of potash.

5. Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.

Wood Ashes.

[I., sent on from Amherst, Mass.; II. and III., sent on from Lawrence, Mass.; IV., sent on from Hudson, Mass.; V., sent on from Clifton, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.18	16.12	8.71	18.00	15.94
Potassium oxide,	4.56	3.94	5.77	4.51	4.71
Calcium oxide,	34.06	30.38	36.95	33.25	31.65
Magnesium oxide,	2.88	2.64	2.90	1.84	2.59
Ferric and aluminic oxides,	1.32	1.32	0.07	1.42	1.62
Phosphoric acid,	1.66	1.52	1.38	1.18	1.43
Insoluble matter (before calcination),	13.60	17.52	13.15	12.99	13.38
Insoluble matter (after calcination),	11.16	13.10	11.88	10.84	10.62

Wood Ashes.

[I., sent on from South Framingham, Mass.; II. and III., sent on from Townsend, Mass.; IV., sent on from South Sudbury, Mass.; V., sent on from Rock Bottom, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.68	13.40	5.28	8.00	1.54
Potassium oxide,	5.48	4.36	5.75	5.41	5.14
Calcium oxide,	37.02	31.25	29.85	38.83	38.64
Magnesium oxide,	3.30	3.81	2.23	3.31	4.18
Ferric and aluminic oxides,	1.09	0.07	1.68	1.00	1.48
Phosphoric acid,	1.26	1.28	2.00	1.27	2.17
Insoluble matter (before calcination),	14.81	18.17	23.03	14.95	15.23
Insoluble matter (after calcination),	12.41	14.50	19.82	11.95	12.43

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I., sent on from Clifton, Mass.; II., sent on from Beverly, Mass.; III., sent on from Hadley, Mass.; IV., sent on from Amherst, Mass.; V., sent on from Marblehead, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	17.44	6.63	15.09	6.68	1.38
Potassium oxide,	5.06	4.12	4.35	5.85	4.81
Calcium oxide,	31.32	42.84	32.87	35.70	28.44
Magnesium oxide,	1.48	2.20	2.89	3.83	2.26
Ferric and aluminic oxides,	0.51	0.45	1.45	0.82	1.66
Phosphoric acid,	1.39	0.84	1.69	1.65	3.47
Insoluble matter (before calcination),	13.80	13.92	14.60	11.54	33.08
Insoluble matter (after calcination),	10.46	12.43	12.07	9.13	26.78

Wood Ashes.

[I., sent on from Tewksbury, Mass.; II. and III., sent on from Sunderland, Mass.; IV. and V., sent on from North Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.90	17.54	3.50	7.46	14.15
Potassium oxide,	6.58	3.15	2.72	7.91	6.95
Calcium oxide,	33.81	29.66	21.23	38.58	31.88
Magnesium oxide,	2.19	3.28	2.39	2.59	1.73
Ferric and aluminic oxides,	1.10	2.62	2.14	0.65	1.25
Phosphoric acid,	1.74	1.87	1.65	1.25	1.42
Insoluble matter (before calcination),	10.00	17.90	44.80	8.11	11.10
Insoluble matter (after calcination),	8.65	12.98	39.69	6.04	8.99

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I., sent on from Sunderland, Mass.; II., sent on from North Hatfield, Mass.; III., sent on from Chicopee, Mass.; IV., sent on from Concord, Mass.; V., sent on from Millington, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.80	16.74	15.70	18.67	1.02
Potassium oxide,	4.44	5.24	4.67	4.90	7.78
Calcium oxide,	–*	33.41	–*	–*	–*
Magnesium oxide,	–*	3.40	–*	–*	–*
Ferric and aluminic oxides,	–*	0.91	–*	–*	–*
Phosphoric acid,	1.79	1.54	1.77	1.68	2.84
Insoluble matter (before calcination),	11.98	10.97	7.72	12.18	13.50
Insoluble matter (after calcination),	9.54	8.65	7.27	9.83	12.55

Wood Ashes.

[I., sent on from Boston, Mass.; II. and III., sent on from Sunderland, Mass.; IV. and V., sent on from Concord, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	9.78	3.94	17.82	11.81	16.20
Potassium oxide,	8.13	4.96	4.04	5.77	5.02
Calcium oxide,	36.77	–*	–*	–*	31.64
Magnesium oxide,	3.24	*	–*	–*	3.03
Ferric and aluminic oxides,	0.36	–*	–*	–*	0.74
Phosphoric acid,	1.60	2.28	1.71	1.68	1.65
Insoluble matter (before calcination),	8.38	23.86	10.56	11.72	11.03
Insoluble matter (after calcination),	6.58	23.42	8.80	9.23	9.07

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I., sent on from Boston, Mass.; II., sent on from South Deerfield, Mass.; III., sent on from North Amherst, Mass.; IV., sent on from Concord, Mass.; V., sent on from Sunderland, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.41	7.05	19.63	10.49	12.60
Potassium oxide,	8.05	6.47	4.10	6.02	5.19
Calcium oxide,	36.10	40.54	33.67	32.42	31.53
Magnesium oxide,	3.17	2.84	1.76	3.60	2.31
Ferric and aluminic oxides,	0.59	0.75	1.06	0.65	1.11
Phosphoric acid,	1.68	1.56	1.61	1.55	1.59
Insoluble matter (before calcination),	8.39	9.08	12.33	11.37	17.15
Insoluble matter (after calcination),	6.49	6.45	10.26	8.37	14.42

Wood Ashes.

[I., sent on from Boston, Mass.; II. and III., sent on from Sunderland, Mass.; IV., sent on from South Deerfield, Mass.; V., sent on from Sudbury, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.46	16.55	25.50	10.40	13.95
Potassium oxide,	5.08	3.36	3.54	4.60	4.04
Calcium oxide,	33.83	27.67	31.29	33.97	27.98
Magnesium oxide,	3.19	1.84	2.14	2.93	4.43
Ferric and aluminic oxides,	0.78	0.94	0.60	1.35	1.59
Phosphoric acid,	1.46	1.54	1.41	1.29	1.51
Insoluble matter (before calcination),	15.76	15.78	14.91	15.03	18.45
Insoluble matter (after calcination),	11.77	13.03	10.29	10.88	12.96

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I., sent on from South Deerfield, Mass.; II., sent on from Sudbury, Mass.; III., sent on from Hingham, Mass.; IV., sent on from Andover, Mass; V., sent on from Byfield, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	1.80	18.25	4.95	38.93	20.12
Potassium oxide,	6.19	3.36	5.64	2.34	6.70
Calcium oxide,	40.00	30.49	33.17	24.15	33.03
Magnesium oxide,	3.21	2.52	–*	–*	–*
Ferric and aluminic oxides,	1.44	1.22	–*	–*	–*
Phosphoric acid,	2.24	1.30	1.28	0.74	1.21
Insoluble matter (before calcination),	11.63	16.97	26.04	5.37	5.30
Insoluble matter (after calcination),	8.72	14.29	22.98	4.40	4.25

* Not determined.

Wood Ashes.

[I., sent on from Methuen, Mass.; II., sent on from Amesbury, Mass.; III., sent on from Readville, Mass.; IV., sent on from Amherst, Mass.; V., sent on from Sudbury, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	20.92	19.17	20.60	17.50	20.52
Potassium oxide,	3.28	3.56	4.82	4.08	3.80
Calcium oxide,	31.60	26.80	33.60	33.40	31.20
Magnesium oxide,	2.95	3.13	2.85	4.46	3.20
Ferric and aluminic oxides,	1.14	2.02	1.05	1.70	1.32
Phosphoric acid,	1.34	1.47	1.40	1.54	0.90
Insoluble matter (before calcination),	17.04	21.55	13.62	16.28	11.36
Insoluble matter (after calcination),	14.43	18.46	12.21	13.44	9.14

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I., sent on from Waltham, Mass.; II., sent on from Hadley, Mass.; III. and IV., sent on from Boston, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	12.58	14.39	9.04	18.90
Potassium oxide,	4.48	3.72	4.38	2.61
Calcium oxide,	33.12	34.12	27.94	37.90
Magnesium oxide,	–*	–*	–*	3.39
Ferric and aluminic oxides,	–*	–*	–*	1.47
Phosphoric acid,	1.34	1.36	1.16	1.16
Insoluble matter (before calcination),	18.68	12.02	27.29	8.92
Insoluble matter (after calcination),	17.55	9.34	23.45	7.15

Cotton-hull Ashes.

[I., sent on from Sunderland, Mass; II. and III, sent on from Hatfield, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	8.55	5.19	5.44
Potassium oxide,	26.68	32.28	12.03
Calcium oxide,	6.27	–*	6.24
Magnesium oxide,	8.48	–*	5.23
Ferric and aluminic oxides,	0.92	–*	4.93
Phosphoric acid,	8.55	7.42	6.12
Insoluble matter (before calcination),	18.93	27.15	45.82
Insoluble matter (after calcination),	15.65	–*	34.86

* Not determined.

5. Analyses, etc. — *Continued.*

Cotton-hull Ashes.

[Three samples, sent on from Agawam, Mass.]

	Per Cent. I.	Per Cent. II.	Per Cent. III.
Moisture at 100° C.,	7.71	4.20	4.58
Potassium oxide,	17.22	21.95	21.75
Calcium oxide,	5.93	9.46	9.66
Magnesium oxide,	8.13	11.50	10.95
Ferric and aluminic oxides,	–*	4.02	3.29
Phosphoric acid,	5.63	10.50	10.36
Insoluble matter (before calcination),	33.55	19.25	19.20
Insoluble matter (after calcination),	30.94	16.62	16.27

* Not determined.

Ivory Ashes.

[Sent on from Springfield, Mass.]

	Per Cent.
Moisture at 100° C.,	1.75
Potassium oxide,	2.44
Calcium oxide,	2.70
Magnesium oxide,	0.83
Ferric and aluminic oxides,	2.33
Total phosphoric acid,	2.05
Soluble phosphoric acid,	0.19
Insoluble matter (before calcination),	89.14
Insoluble matter (after calcination),	71.48

Lime-kiln Ashes.

[Sent on from Sunderland, Mass.]

	Per Cent.
Moisture at 100° C.,	0.00
Potassium oxide,	2.12
Calcium oxide,	56.28
Phosphoric acid,	1.21
Insoluble matter (before calcination),	15.11
Insoluble matter (after calcination),	12.63

5. Analyses, etc. — *Continued.*

Corn-cob Ashes.

	Per Cent.
Moisture at 100° C.,	1.20
Potassium oxide,	7.08
Calcium oxide,	11.70
Magnesium oxide,	–*
Ferric and aluminic oxides,	1.28
Phosphoric acid,	2.37
Insoluble matter (before calcination),	59.14
Insoluble matter (after calcination),	52.09

Ashes.

[Sent on from Cambridge, Mass.]

	Per Cent.
Moisture at 100° C.,	4.98
Potassium oxide,	10.64
Phosphoric acid,	6.96
Insoluble matter (before calcination),	23.16
Insoluble matter (after calcination),	20.01

Wool Waste.

[Sent on from North Andover, Mass.]

	Per Cent.
Moisture at 100° C.,	4.47
Potassium oxide,	1.32
Nitrogen,	2.27
Insoluble matter,	39.30

Horn Shavings.

[Sent on from Leominster, Mass.]

	Per Cent.
Moisture at 100° C.,	4.83
Ash,	0.67
Phosphoric acid,	0.42
Nitrogen,	15.31
Insoluble matter,	Trace.

* Not determined.

5. Analyses, etc. — *Continued.*

Tobacco Leaves.

[Sent on from Whately, Mass.]

	Per Cent.
Moisture at 100° C.,	13.05
Ash,	21.01
Potassium oxide,	7.24
Calcium oxide,	4.17
Magnesium oxide,	2.17
Ferric and aluminic oxides,	0.32
Phosphoric acid,	0.43
Nitrogen,	2.75
Insoluble matter,	4.17

I., Pine Needles; II., Pine Barren Grass.

[Sent on from Springfield, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	9.48	8.48
Ash,	3.42	2.40
Phosphoric acid,	0.12	0.18
Potassium oxide,	0.03	0.07
Nitrogen,	0.46	0.10
Insoluble matter,	1.22	1.07

Peat.

[Sent on from Weston, Mass.]

	Per Cent.
Moisture at 100° C.,	10.73
Ash,	17.26
Phosphoric acid,	0.03
Potassium oxide,	0.06
Nitrogen,	1.73
Insoluble matter,	10.14

Sludge.

[Sent on from Worcester, Mass.]

	Per Cent.
Moisture at 100° C.,	6.28
Ash,	70.05
Phosphoric acid,	1.36
Calcium oxide,	8.66
Ferric and aluminic oxides,	17.68
Nitrogen,	0.68
Insoluble matter,	38.03

5. Analyses, etc. — *Continued.*

Muck.

[I , surface layer, one and one-half to four and one-half feet deep; II., under layer, four to six feet below surface, sent on from West Bridgewater, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	76.18	87.78
Ash,	8.24	1.23
Phosphoric acid,	0.08	0.02
Calcium oxide,	0.38	0.14
Nitrogen,	0.43	0.18
Insoluble matter,	6.45	0.63

Soot.

[Sent on from East Walpole, Mass.]

	Per Cent.
Moisture at 100° C.,	8.00
Ash,	88.98
Potassium oxide,	0.56
Calcium oxide,	3.50
Magnesium oxide,	0.83
Ferric and aluminic oxides,	2.01
Phosphoric acid,	0.83
Insoluble matter (before calcination),	82.52
Insoluble matter (after calcination),	80.72

Drainage from Manure Heaps.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	93.25
Ash,	3.66
Phosphoric acid,	0.24
Potassium oxide,	0.88
Total nitrogen,	0.98
Nitrogen as ammonia,	0.65

5. Analyses, etc. — *Continued.*

Muriate of Potash.

[I., sent on from Amherst, Mass.; II. and III., sent on from South Hadley Falls, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	0.54	1.07	0.85
Potassium oxide,	51.44	49.60	50.24
Insoluble matter,	Trace.	Trace.	Trace.

Sulphate of Potash.

[Sent on from Hatfield, Mass.]

	Per Cent.
Moisture at 100° C.,	2.22
Potassium oxide,	47.00
Insoluble matter,	Trace.

Gypsum (Land Plaster).

[Sent on from Millington, Mass.]

	Per Cent.
Moisture at 100° C.,	14.01
Calcium oxide,	33.45
Sulphuric acid,	46.86
Carbonic acid,	Trace.
Insoluble matter,	0.63

Gypse (Calcium Carbonate).

[Sent on from Pittsfield, Mass.]

	Per Cent.
Moisture at 100° C.,	1.64
Calcium oxide,	50.87
Insoluble matter,	2.87

5. Analyses, etc. — *Continued.*

Florida Phosphates.

[I., II. and III., sent on from Concord, Mass.; IV., sent on from Marlborough, Mass.; V., sent on from Townsend, Mass.; VI., from station barn.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	1.38	0.36	1.51	2.24	3.08	2.53
Ash,	94.99	96.20	91.93	86.63	–*	89.52
Phosphoric acid,	36.80	36.26	33.88	17.71	17.24	21.72
Calcium oxide,	46.21	51.78	45.53	14.64	25.62	17.89
Ferric and aluminic oxides,	8.38	5.62	9.80	6.72	11.00	14.25
Carbonic acid,	–*	–*	–*	–*	4.45	1.83
Insoluble matter,	1.42	2.20	1.47	13.37	29.22	30.50

Virginia Phosphatic Marls.

[I. and II., sent on from Arlington, Mass.; III., IV. and V., sent on from Enfield, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	1.30	1.10	1.25	1.97	3.30
Ash,	94.85	90.94	–*	–*	–*
Total phosphoric acid,	9.06	5.99	9.37	13.73	10.39
Soluble phosphoric acid,	0.26	0.08	0.00	0.00	0.00
Reverted phosphoric acid,	0.15	0.22	0.00	0.00	0.41
Insoluble phosphoric acid,	8.65	5.69	9.37	13.73	9.98
Potassium oxide,	–	–	1.14	0.24	Trace.
Calcium oxide,	20.47	19.74	25.78	19.16	–*
Ferric and aluminic oxides,	5.76	6.60	5.13	6.00	–*
Nitrogen,	–	–	–	–	1.61†
Insoluble matter,	59.56	54.95	41.32	50.55	–

* Not determined. † Addition, from an outside source.

5. Analyses, etc. — *Continued.*

Ground Bone.

[I., sent on from Northborough, Mass.; II. and III., sent on from Westborough, Mass.; IV., sent on from Townsend, Mass.]

Mechanical Analyses.

	Per Cent.			
	I.	II.	III.	IV.
Fine,	51.57	47.50	46.93	37.30
Fine medium,	36.59	23.96	24.76	20.01
Medium,	11.84	16.10	17.46	24.83
Coarse medium,	–	12.44	10.85	17.86

Chemical Analyses.

Moisture at 100° C.,	3.30	2.28	2.85	3.50
Ash,	57.56	62.86	65.61	72.43
Total phosphoric acid,	23.50	26.07	27.07	26.23
Soluble phosphoric acid,	0.26	0.31	0.26	0.14
Reverted phosphoric acid,	7.43	8.16	9.10	5.28
Insoluble phosphoric acid,	15.81	17.60	17.71	20.81
Nitrogen,	4.02	2.71	2.90	2.12
Insoluble matter,	1.14	Trace.	Trace.	0.30

Bone Dust.

[Sent on from Hatfield, Mass.]

	Per Cent.
Moisture at 100° C.,	9.70
Total phosphoric acid,	26.39
Soluble phosphoric acid,	0.15
Reverted phosphoric acid,	14.32
Insoluble phosphoric acid,	11.92
Nitrogen,	3.74
Insoluble matter,	Trace.

Ivory Dust.

[Sent on from Lincoln, Mass.]

	Per Cent.
Moisture at 100° C.,	11.50
Ash,	52.63
Total phosphoric acid,	24.56
Soluble phosphoric acid,	0.97
Reverted phosphoric acid,	17.97
Insoluble phosphoric acid,	5.62
Nitrogen,	6.64

5. Analyses, etc. — *Continued.*

Blood, Meat and Bone.

[Sent on from Holyoke, Mass.]

	Per Cent.
Moisture at 100° C.,	19.94
Ash,	19.76
Total phosphoric acid,	7.16
Soluble phosphoric acid,	0.51
Reverted phosphoric acid,	3.78
Insoluble phosphoric acid,	2.87
Nitrogen,	7.44
Insoluble matter,	0.52

Fish.

[I , sent on from Marshfield, Mass.; II., sent on from Danvers, Mass.; III., sent on from Marblehead, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	37.88	6.96	6.17
Ash,	33.68	19.69	33.75
Total phosphoric acid,	5.45	8.14	15.10
Soluble phosphoric acid,	Trace.	–*	–*
Reverted phosphoric acid,	1.09	–*	–*
Insoluble phosphoric acid,	4.36	–*	–*
Nitrogen,	5.13	8.70	7.16
Insoluble matter,	0.21	1.07	2.77

I., Rat Guano (Virginia); II. and III., Bat Guanos (Virginia).

[Sent on from Lake Weir, Fla.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	10.32	12.15	19.18
Ash,	–*	–*	68.40
Phosphoric acid,	2.30	3.26	3.44
Potassium oxide,	6.85	1.77	–
Nitrogen,	3.32	9.74	–
Insoluble matter,	1.15	5.77	32.89

* Not determined.

5. ANALYSES, ETC. — *Concluded.*

Cotton-seed Meal.

[Sent on from Sunderland, Mass.]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	4.35	5.83
Ash,	3.35	6.77
Phosphoric acid,	3.51	3.33
Potassium oxide,	2.25	2.01
Nitrogen,	6.86	6.66
Insoluble matter,	0.09	0.28

Home-mixed Fertilizers.

[I., sent on from Littleton, Mass.; II., sent on from Eastham, Mass.]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	10.05	8.80
Ash,	62.74	78.24
Total phosphoric acid,	7.04	5.97
Soluble phosphoric acid,	5.77	5.21
Reverted phosphoric acid,	1.14	0.45
Insoluble phosphoric acid,	0.13	0.31
Potassium oxide,	18.56	18.08
Nitrogen,	3.38	4.68
Insoluble matter,	3.51	1.05

Complete Fertilizer.

[I., sent on from Norfolk, Mass.; II., sent on from Greenfield, Mass.; III. and IV.,* sent on from Eastham, Mass.]

	Per Cent. I.	Per Cent. II.	Per Cent. III.	Per Cent. IV.
Moisture at 100° C.,	8.61	6.90	9.92	8.35
Ash,	60.23	–†	–†	–†
Total phosphoric acid	9.98	8.32	9.34	20.60
Soluble phosphoric acid,	5.99	2.56	0.51	0.64
Reverted phosphoric acid,	3.45	3.46	3.71	8.19
Insoluble phosphoric acid,	0.54	2.30	5.12	11.77
Potassium oxide,	0.91	10.23	0.98	–
Nitrogen,	1.80	3.84	7.36	4.35
Insoluble matter,	7.67	–†	–†	–†

* Not a complete fertilizer, lacks potash. † Not determined.

6. Miscellaneous Analyses.

Exudation from an Elm Tree.

[Sent on from Greenfield, Mass]

	Per Cent.
Moisture at 100° C.,	10.92
Glucose,	10.56
Sucrose,	72.62
Matter insoluble in water,	1.45
Resinous matter soluble in alcohol,	0.15

I., Skin or Husk Covering of the Coffee-cherry; II., Parchment Covering of the Coffee-bean.

[Sent on from Cambridge, Mass]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	9.69	8.57
Ash,	7.78	4.27
Phosphoric acid,	0.43	0.13
Potassium oxide,	1.55	0.97
Nitrogen,	1.27	0.78
Insoluble matter,	2.87	1.72

Baking Powder.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	15.20
Sodium oxide,	12.56
Calcium oxide,	6.60
Aluminium oxide,	3.31
Total carbonic acid,	12.40
Available carbonic acid,	11.65
Phosphoric acid,	12.49
Sulphuric acid,	15.98
Nitrogen,	1.13
Starch,	18.30
Insoluble matter,	0.73

6. Miscellaneous Analyses — *Concluded.*

Preservaline.

[Sent on from Brightwood, Mass]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	5.56	3.96
Sodium oxide,	32.16	26.81
Potassium oxide,	0.80	15.79
Calcium oxide,	Trace	Trace.
Chlorine,	21.79	23.09
Nitrogen,	0.26	4.90
Sulphuric acid,	1.04	1.43
Insoluble matter,	0.08	0.09

Cider.

[Sent on from North Amherst, Mass.]

	Per Cent.
Alcohol,	4.53
Acid calculated as acetic,	0.60
Solid residue,	1.79

Vinegar.

	Per Cent.
Specific gravity,	1.00939
Acetic acid,	6.18
Solid residue,	1.33

Damaged Oats.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	13.70
Dry matter,	86.30
	100.00

Analysis of Dry Matter.

Crude ash,	4.03
" cellulose,	12.44
" fat,	5.96
" protein,	12.59
Non-nitrogenous extract matter,	64.98
	100.00

II.

Analyses of Milk sent on for Examination.

[Per Cent.]

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1, . .	15.23	6.92	8.31	North Adams.	
2, . .	7.79	0.41	7.38	Amherst.	Buttermilk.
3, . .	8.09	0.48	7.61	"	"
4, . .	8.48	0.36	8.12	"	"
5, . .	8.62	0.82	7.80	"	"
6, . .	8.78	0.27	8.51	"	"
7, . .	8.01	0.51	7.50	"	"
8, . .	13.25	4.25	9.00	Northborough.	
9, . .	15.38	6.00	9.38	Worcester.	
10, . .	11.72	3.69	8.03	Lancaster.	
11, . .	10.00	1.84	8.16	"	
12, . .	12.64	3.83	8.81	"	
13, . .	11.35	2.86	8.49	"	
14, . .	11.75	3.19	8.56	"	
15, . .	11.76	4.09	7.67	"	
16, . .	12.59	3.71	8.88	"	
17, . .	10.36	2.90	7.46	"	
18, . .	13.80	3.99	8.81	"	
19, . .	12.30	3.40	8.90	"	
20, . .	11.00	3.19	7.81	"	
21, . .	11.49	3.18	8.31	"	
22, . .	11.21	2.38	8.83	Chicopee.	
23, . .	11.74	3.62	8.12	Warren.	
24, . .	12.03	3.90	8.13	"	
25, . .	13.40	4.39	9.01	"	
26, . .	11.15	2.90	8.25	"	
27, . .	12.69	4.08	8.61	"	
28, . .	12.56	4.01	8.55	"	
29, . .	12.82	4.40	8.42	West Brookfield.	
30, . .	12.58	3.79	8.79	"	
31, . .	14.72	5.52	9.20	New Braintree.	
32, . .	14.36	5.02	9.34	"	
33, . .	15.07	5.65	9.42	"	
34, . .	16.50	7.17	9.33	"	
35, . .	13.73	4.78	8.95	"	
36, . .	13.92	4.86	9.06	"	
37, . .	13.90	5.06	8.84	"	
38, . .	13.21	4.36	8.85	"	
39, . .	14.63	5.34	9.29	"	

Analyses of Milk, etc. — *Concluded.*

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
40, . .	15.54	6.33	9.21	New Braintree.	
41, . .	12.83	4.17	8.66	"	
42, . .	13.31	4.61	8.70	"	
43, . .	12.28	3.25	9.03	Warren.	
44, . .	12.27	3.25	9.02	"	
45, . .	15.18	4.67	10.51	"	
46, . .	11.86	3.01	8.85	"	
47, . .	12.54	3.49	9.05	"	
48, . .	12.43	3.32	9.11	"	
49, . .	14.93	6.86	8.07	Furnace.	
50, . .	11.94	3.44	8.50	"	
51, . .	12.20	3.48	8.72	Old Furnace.	
52, . .	12.58	3.52	9.06	"	
53, . .	11.95	3.19	8.76	Furnace.	
54, . .	12.13	3.54	8.59	"	
55, . .	13.82	4.09	9.73	"	
56, . .	12.09	3.62	8.47	"	
57, . .	13.02	4.14	8.88	"	
58, . .	11.61	2.98	8.63	"	
59, . .	11.98	3.35	8.63	"	
60, . .	12.55	3.68	8.87	"	
61, . .	11.93	3.34	8.59	"	
62, . .	12.47	3.81	8.66	"	
63, . .	12.07	3.62	8.45	South Lancaster.	
64, . .	12.42	3.68	8.74	"	
65, . .	11.43	3.12	8.31	"	
66, . .	10.63	2.86	7.77	"	
67, . .	11.65	3.53	8.12	"	
68, . .	11.62	3.31	8.31	"	
69, . .	12.33	4.17	8.16	"	
70, . .	11.56	3.11	8.45	Chicopee.	
71, . .	11.51	3.76	7.75	"	
72, . .	11.86	3.76	8.10	"	
73, . .	13.35	4.71	8.64	North Amherst.	
74, . .	13.13	4.14	8.99	"	

Analysis of Milk sent on for Examination.

[Babcock Mode.]

Number of Sample.	Fat (Per Cent.).	Locality.	Number of Sample.	Fat (Per Cent.).	Locality.
1, . . .	6.30	Hadley.	21, . .	4.90	Amherst.
2, . . .	5.60	"	22, . .	3.70	"
3, . . .	5.25	"	23, . .	3.70	"
4, . . .	5.20	"	24, . .	3.80	"
5, . . .	4.25	"	25, . .	4.50	"
6, . . .	4.45	"	26, . .	3.30	"
7, . . .	5.40	"	27, . .	4.00	"
8, . . .	5.50	"	28, . .	4.10	"
9, . . .	5.50	"	29, . .	5.40	"
10, . . .	4.65	"	30, . .	3.30	"
11, . . .	4.40	"	31, . .	3.30	"
12, . . .	5.15	"	32, . .	3.60	"
13, . . .	5.80	"	33, . .	3.90	"
14, . . .	4.85	"	34, . .	3.40	"
15, . . .	5.60	"	35, . .	3.00	"
16, . . .	4.40	"	36, . .	3.00	"
17, . . .	5.25	"	37, . .	3.30	"
18, . . .	2.80	Amherst.	38, . .	2.90	"
19, . . .	3.00	"	39, . .	3.00	"
20, . . .	2.10	"			

III.

Analyses of Water sent on for Examination.*

[Parts per million]

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
1	.004	.100	4.00	116.00	40.00	0.48	None.	Amherst.
2	.990	.440	15.00	164.00	54.00	2.47	None.	Weston.
3	.080	.270	9.00	105.00	45.00	2.73	None.	Weston.
4	.260	.964	34.00	237.00	130.00	-	-	Grafton.
5	.010	.096	8.00	90.00	30.00	2.08	None.	North Amherst.
6	.006	.106	5.00	110.00	60.00	1.95	None.	Amherst.
7	.066	.248	33.00	236.00	86.00	2.21	-	Amherst.
8	.020	.340	66.00	294.00	84.00	4.43	None.	Medway.
9	.100	.298	13.00	172.00	60.00	-	-	Worcester.
10	.146	.352	70.00	434.00	112.00	8.86	None.	Cochituate.
11	.010	.170	2.00	72.00	22.00	0.95	None.	Amherst.
12	.024	.112	8.00	70.00	20.00	2 86	None.	Amherst.
13	.217	.248	85.00	640.00	381.00	11.05	None.	Weston.
14	.047	.107	20.00	84.00	22.00	1.43	None.	Billerica.
15	.051	.595	3.00	206.00	90.00	5.57	None.	Amherst.
16	.020	.088	4.00	50.00	26.00	0.00	None.	Weston.
17	.044	.069	8.00	130.00	82.00	1.69	None.	Weston.
18	.226	.362	12.00	192.00	62.00	1.27	-	Prescott.
19	.096	.256	30.00	248.00	108.00	5.29	-	North Hadley.
20	.108	.238	7.00	276.00	136.00	-	-	Amherst.
21	.052	.438	6.00	150.00	30.00	2.47	None.	Littleton.
22	.576	.444	7.00	140.00	48.00	2.99	None.	Littleton.
23	.030	.225	65.00	474.00	264.00	14.21	None.	Barre.
24	.249	.163	28.00	320.00	176.00	2.73	-	South Deerfield.
25	.394	.472	2.00	106.00	32.00	0.63	None.	South Amherst.
26	-	-	-	-	-	-	None.	Amherst.

* Analysis of well water at the station is confined to chemical tests with reference to an excess of foreign matter from sinks, barns, etc.

ANALYSES OF WATER, ETC. — *Continued.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat	Hardness (Clark's Degree).	Lead.	Locality.
27	.104	.128	24.00	128.00	64.00	2.99	None.	Concord.
28	.112	.180	64.00	440.00	168.00	6.00	None.	Concord.
29	.080	.128	22.00	232.00	96.00	2.73	None.	Concord.
30	.424	.612	44.00	496.00	216.00	5.14	None.	Concord.
31	.032	.068	9.00	114.00	80.00	3.12	None.	South Amherst.
32	.024	.096	5.00	44.00	17.00	-	-	Greenwich.
33	.078	.466	170.00	638.00	474.00	13.91	-	Orange.
34	.038	.114	10.00	60.00	28.00	1.68	None.	Weston.
35	.130	.164	44.00	154.00	50.00	0.76	None.	Montague.
36	.072	.228	6.00	124.00	52.00	2.21	-	Barre.
37	.070	.257	14.00	132.00	20.00	1.69	-	East Foxborough.
38	.016	.260	2.00	44.00	24.00	1.95	-	Shirley.
39	.008	.160	26.00	148.00	58.00	4.16	-	Shirley.
40	.020	.206	4.00	260.00	32.00	1.43	-	Shirley.
41	.012	.146	3.00	64.00	18.00	0.48	-	Shirley.
42	.061	.235	24.00	194.00	62.00	4.29	None.	Amherst.
43	.018	.128	5.00	90.00	48.00	1.11	None.	Barre.
44	.030	.077	9.00	122.00	46.00	0.92	None.	Boston.
45	.028	.248	20.00	210.00	60.00	3 25	-	Amherst.
46	.112	.370	5.00	50.00	6.00	0.00	None.	Concord.
47	.022	.344	4.00	54.00	10.00	0.16	None.	Concord.
48	.050	.260	4.00	52.00	10.00	1.27	None.	Concord.
49	.022	.254	5.00	54.00	10.00	0.00	None.	Concord.
50	.004	.090	3.00	30.00	10.00	1.95	None	Hadley.
51	.005	.212	8.00	-	-	-	-	Hadley.
52	.036	.056	5.00	162.00	104.00	3.38	None.	Littleton.
53	.040	.130	20.00	208.00	78.00	4.03	None.	Littleton.
54	.072	.108	13.00	102.00	42.00	1.69	None.	Littleton.
55	.032	.232	24.00	204.00	80.00	4.43	None.	Littleton.
56	.024	.324	16.00	170.00	56.00	3.25	None.	Amherst.
57	.058	.085	9.00	86.00	18.00	1.43	-	East Foxborough.
58	.208	.132	20.00	196.00	66.00	4.86	None.	Amherst.
59	.240	.186	13.00	168.00	54.00	2.08	None.	Leverett.
60	.116	.096	36.00	280.00	34.00	3.38	None.	Amherst.

Analyses of Water, etc. — *Continued.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
61	.172	.552	11.00	150.00	30.00	1.95	None.	South Amherst.
62	.076	.170	44.00	294.00	124.00	5.86	-	Amherst.
63	.072	.193	13.00	226.00	112.00	2.73	None.	Northampton.
64	.342	.612	46.00	-	-	-	-	Amesbury.
65	.012	.126	50.00	142.00	60.00	1.43	-	Amesbury.
66	.007	.060	9.00	190.00	140.00	6.14	-	Springfield.
67	.014	.162	18.00	190.00	64.00	2.60	-	South Amherst.
68	.027	.090	10.00	190.00	60.00	3.25	None.	Agawam.
69	.036	.088	15.00	168.00	78.00	1.56	-	Amherst.
70	.012	.042	3.00	72.00	28.00	0.63	-	North Amherst.
71	.022	.039	8.00	96.00	60.00	0.95	-	Amherst.
72	.016	.116	6.00	68.00	12.00	0.00	-	Westminster.
73	.000	.076	34.00	184.00	76.00	3.51	-	Concord.
74	.048	.088	14.00	140.00	52.00	2.21	-	Concord.
75	.012	.096	8.00	188.00	84.00	1.27	-	Concord.
76	.016	.080	46.00	336.00	124.00	4.16	-	Concord.
77	.040	.140	6.00	104.00	52.00	0.32	-	Concord.
78	.024	.112	8.00	-	-	3.90	-	Chesterfield.
79	.100	.216	30.00	328.00	72.00	6.86	-	South Deerfield.
80	.016	.060	14.00	176.00	96.00	2.21	-	Medway.
81	1.340	.140	10.00	344.00	116.00	5.14	-	Smithville.
82	.036	.444	5.00	116.00	44.00	2.21	-	Ludlow.
83	.116	.212	4.00	180.00	104.00	2.08	-	Ludlow.
84	.144	.236	5.00	204.00	70.00	1.95	-	Ludlow.
85	.000	.064	20.00	248.00	80.00	3.25	-	Amherst.
86	.012	.048	6.00	114.00	60.00	0.16	-	Amherst.
87	.048	.128	3.00	-	-	4.57	-	Amherst.
88	.012	.048	18.00	160.00	64.00	2.73	-	South Deerfield.
89	.156	.100	32.00	348.00	116.00	6.71	-	South Deerfield.
90	.008	.176	12.00	196.00	68.00	0.63	-	Amherst.
91	.016	.088	14.00	172.00	100.00	3.51	-	Weston.
92	.176	.120	42.00	360.00	176.00	1.95	None.	Plainville.
93	.104	.076	24.00	-	-	7.29	None.	North Hadley.
94	.016	.084	4.00	244.00	132.00	2.34	-	North Amherst.

ANALYSES OF WATER, ETC. — *Concluded.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
95	.000	.148	6.00	160.00	44.00	0.32	None.	Bolton.
96	.108	.056	8.00	168.00	92.00	2.47	None.	Weston.
97	.000	.072	4.00	136.00	64.00	0.32	None.	Rockville.
98	2.032	.168	42.00	324.00	164.00	8.86	–	North Hadley.
99	.088	.123	8.00	304.00	156.00	6.29	–	Amherst.
100	.280	.264	16.00	268.00	164.00	1.82	–	South Sudbury.
101	.008	.116	36.00	–	–	3.51	–	Amherst.
102	.048	.112	8.00	124.00	48.00	1.69	–	South Deerfield.
103	.112	.120	8.00	200.00	88.00	2.47	–	Westford.
104	.040	.076	6.00	172.00	64.00	3.25	–	Weston.
105	.012	.068	8.00	142.00	46.00	2.34	–	Waltham.
106	1.468	.368	26.00	548.00	312.00	8.00	–	North Andover.
107	.160	.272	108.00	472.00	148.00	8.71	–	North Andover.
108	.100	.128	10.00	180.00	68.00	3.25	–	North Andover.
109	.040	.128	15.00	100.00	28.00	3.38	–	Templeton.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wancklyn and E. T. Chapman.)

Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon * of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water

* One gallon equals 70,000 grains.

is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight hundredth parts per million of free ammonia and one tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

An examination of the previously stated analyses indicates that Nos. 2, 3, 4, 9, 10, 13, 18, 19, 20, 22, 24, 25, 27, 28, 29, 30, 35, 46, 58, 59, 60, 61, 64, 79, 81, 83, 84, 89, 92, 93, 96, 98, 99, 100, 103, 106, 107 and 108 ought to be condemned as unfit for family use; while Nos. 7, 8, 14, 15, 21, 23, 33, 36, 37, 42, 48, 53, 54, 62, 63, 82 and 109 must be considered suspicious. From this record it will be seen that over one-third of the entire number of well waters tried proved unfit for drinking. Heating waters to the boiling point not unfrequently removes immediate danger.

Parties sending on water for analysis should be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One gallon is desirable for the analysis.

IV. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

Prepared by C. S. Crocker.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1893.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1892, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years.

C. A. G.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	61	1.95	–	–	–	–	58.98	45.94	**51.37**	–	–	–	–	–	–	6.69	–	.55	–	–	–	48.80	.70
Sulphate of potash,	22	2.71	–	–	–	–	51.28	21.36	**33.65**	–	–	–	–	–	–	4.46	–	1.50	–	45.72	–	–	.75
Sulphate of potash and magnesia,	15	4.75	–	–	–	–	29.48	16.96	**23.50**	–	–	–	–	–	–	6.25	2.57	–	–	44.25	–	2.60	1.41
Kainite,	4	3.20	–	–	–	–	16.48	12.51	**13.54**	–	–	–	–	–	–	18.97	1.15	9.80	–	20.25	–	33.25	2.13
Carnallite,	1	–	–	–	–	–	–	–	**13.68**	–	–	–	–	–	–	7.66	–	13.19	–	.56	–	41.56	–
Krugite,	1	4.82	–	–	–	–	–	–	**8.42**	–	–	–	–	–	–	5.27	12.45	8.79	–	31.94	–	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.82	17.30	–	36.10	–	–	5.73
Nitrate of potash,	2	1.93	–	14.58	11.60	**13.09**	45.62	44.76	**45.19**	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitrate of soda,	22	1.40	–	16.01	14.44	**15.70**	–	–	–	–	–	–	–	–	–	35.50	–	–	–	–	–	.50	.50
Sulphate of ammonia,	24	1.00	–	21.68	19.70	**20.50**	–	–	–	–	–	–	–	–	–	–	–	–	–	60.00	–	–	–
Saltpetre waste,	11	2.60	–	3.30	.52	**2.28**	30.94	1.55	**14.34**	–	–	–	–	–	–	36.50	.75	.19	–	1.85	–	48.30	–
Nitre salt-cake,	2	6.03	–	–	–	**2.29**	–	–	**.87**	–	–	–	–	–	–	29.56	–	–	–	47.77	–	–	3.92
Wood ashes,	231	12.36	–	–	–	–	10.80	2.32	**5.21**	5.58	.51	**1.70**	–	–	–	–	33.88	3.31	.96	–	–	–	13.98
Cotton-seed-hull ashes,	36	7.49	–	–	–	–	42.12	9.91	**22.41**	13.67	2.89	**8.43**	–	–	–	–	9.33	10.47	1.71	–	–	–	13.51
Ashes of spent tan-bark,	5	4.84	–	–	–	–	2.87	.60	**1.81**	2.77	.13	**1.36**	–	–	–	–	31.11	3.39	1.78	–	–	–	25.21
Corn-cob ashes,	1	1.20	–	–	–	–	–	–	**7.08**	–	–	**2.37**	–	–	–	–	11.70	–	1.28	–	–	–	52.09

Railroad tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypsum,	2	13.52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.09	-	-	47.41	-	-	.59
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster,	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.85	.75	-	45.75	-	-	2.50
Onondaga plaster,	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime kiln ashes,	8	15.45	-	-	-	-	2.12	.02	1.02	3.16	.36	1.18	-	-	-	-	46.23	2.60	-	-	17.75	-	8.79
Marls (Massachusetts),	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia),	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia),	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia),	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl,	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina),	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
II. Guanos, Phosphates, etc.																							
Peruvian guano,	26	14.81	37.61	13.50	4.44	**7.85**	4.08	1.14	**2.61**	20.60	5.96	**15.26**	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	**6.47**	-	-	**1.31**	6.53	1.00	**3.76**	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida,	2	15.66	-	-	-	**9.74**	-	-	**1.77**	3.44	3.26	**3.35**	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida,	1	10.32	-	-	3.32	-	-	-	**6.85**	-	-	**2.30**	-	-	-	-	-	-	-	-	-	-	1.15
Cuba guano,	5	24.27	-	2.74	.63	**1.67**	-	-	-	16.16	11.54	**13.35**	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla),	12	7.31	-	-	-	-	-	-	-	35.43	18.11	**26.77**	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Mona Island guano,	1	13.32	-	-	-	**.76**	-	-	-	-	-	**21.88**	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45
South Carolina rock phosphate,	5	1.50	-	-	-	-	-	-	-	30.51	25.81	**28.03**	.27	.07	27.69	-	41.87	3.03	4.80	-	-	-	9.04
Florida rock phosphate,	26	2.12	-	-	-	-	-	-	-	38.97	6.95	**26.90**	-	-	-	-	30.32	-	7.59	-	-	-	27.33
Soft Florida phosphate,	1	2.24	-	-	-	-	-	-	-	-	-	**17.71**	-	-	-	-	14.64	-	6.72	-	-	-	13.37
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	**34.27**	-	-	-	-	37.45	-	10.27	-	-	-	2 70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	**35.21**	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	**23 49**	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Dissolved bone-black,	2	7.50	47.50	-	-	-	-	-	-	17.54	15.35	**16.45**	15.60	.60	.19	-	-	-	-	-	-	-	1.50
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	**28.28**	-	-	-	-	-	-	-	-	-	-	3.64
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	**35.89**	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	**14.23**	**69.95**	-	-	-	-	-	-	-	-	**14.64**	10.34	2 42	1.88	-	-	-	-	-	-	-	10.81

III. Refuse Substances.																						
Dried blood,	14	12.50	6.37	13.55	8.10	10.52	-	-	-	6.23	1.53	1.91	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	39.05
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-		-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	8	14.26	24.10	10.20	1.05	5.27	3.08	.06	1.21	.67	.05	.35	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	139	7.39	56.03	4.70	1.62	4.01	-	-	-	32.52	15.16	23.34	.39	7.92	15.28	-	-	-	-	-	-	-	1.09
Tankage,	17	12.93	29.77	8.07	4.16	6.69	-	-	-	18.86	7.39	11.00	.31	5.02	5.67	-	-	-	-	-	-	-	1.27
Fish with less than twenty per cent. water,	60	12.63	21.50	11.40	6.81	7.24	-	-	-	11.26	5.50	8.24	.55	2.60	5.10	-	-	-	-	-	-	-	2.01

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Concluded.																							
Fish with between twenty and forty per cent water.	10	30.19	20.59	7.41	4.22	**5.97**	-	-	-	8.32	4.68	**7 09**	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	**4.97**	-	-	-	8.56	2.94	**5.08**	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	**4.86**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	**4.50**	-	-	-	-	-	**3.52**	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	4	9.98	5.70	5.72	5.33	**5.56**	1.70	.64	**1.12**	2.22	1.57	**2.16**	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	18	5.74	5.78	7.26	4.02	**6.64**	2.09	.89	**1.72**	3.36	1.26	**1.82**	-	-	-	-	.39	.99	-	-	-	-	.40
Rotten brewers' grain,	1	78.77	-	-	-	**.72**	-	-	**.04**	-	-	**.43**	-	-	-	-	.26	.15	-	-	-	-	.59
Tobacco leaf,	1	13.05	21.01	-	-	**2.75**	-	-	**7.24**	-	-	**.43**	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	6	10.61	14.07	2.91	.90	**2.29**	8.82	3.76	**6.44**	2.09	.44	**.60**	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	**1.30**	-	-	**.80**	-	-	**1.54**	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	3	6.44	60.60	2.09	.96	**1.50**	1.62	.66	**1.10**	.84	.26	**.52**	-	-	-	-	-	-	-	-	-	-	45.00
Cotton dust,	1	34.46	50.93	-	-	**.50**	-	-	**.19**	-	-	**.21**	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse,	1	8.10	-	-	-	**2.62**	-	-	**.15**	-	-	**.29**	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	**.68**	-	-	-	-	-	**.67**	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	**.98**	-	-	**.11**	-	-	**.20**	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	**.24**	-	-	**5.46**	-	-	**1.80**	-	-	-	-	-	-	-	-	-	-	-
Sumac waste,	1	63.06	6.80	-	-	**1.19**	-	-	**3.25**	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	**.83**	1.61	.21	**.91**	.41	.22	**.32**	-	-	-	1.63	2.13	.11	-	-	-	-	1.06

Pine barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-	-	1 36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	14	57.50	13.75	2.54	.26	1.05	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat,	10	61.50	8.20	1.40	.41	.85	-	-	.18	-	-	.08	-	-	-	-	.52	.72	2.14	-	-	-	2.20
Peat,	1	10.73	17.26	-	-	1.73	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	1	5.54	77.10	-	-	-	-	-	1.83	-	-	-	-	-	-	-	-	-	-	-	-	-	35.34
IV. Animal Excrement, etc.																							
Barn-yard manure,	34	69.49	-	.87	.21	.49	.85	.13	.45	.75	.10	.33	-	-	-	-	.30	.19	-	-	-	-	6.20
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen manure, dry,	1	8.35	-	-	-	2.13	-	-	9.94	-	-	2.02	-	-	-	-	2.22	.62	-	-	-	-	34.64

V. Compilation of Analyses of Fodder Articles, Fruits, Sugar-producing Plants, Dairy Products, etc.,

made at

AMHERST, MASS.

1868-1893.

Prepared by C. S. Crocker.

A. Analyses of Fodder Articles.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

C. Analyses of Fruit.

D. Analyses of Sugar-producing Plants.

E. Dairy Products.

F. Insecticides.

A. Analyses of Fodder Articles.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain—													Nutritive Ratio (Average).
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
I. Green Fodders.																		
Fodder corn,	25	30.53	10.33	**19.36**	17.19	7.62	**10.24**	6.10	1.42	**2.44**	63.13	42.02	**55.51**	31.53	19.26	**25.90**	5.91	1:9.93
Fodder corn ensilage,	32	37.43	13.12	**21.97**	12.58	5.98	**8.48**	6.49	1.82	**3.92**	65.69	42.99	**54.79**	38.92	17.67	**27.49**	5.37	1:10.48
Corn and soja bean ensilage,	1	-	-	**28.97**	-	-	**15.27**	-	-	**5.35**	-	-	**40.50**	-	-	**37.84**	11.04	1:5.32
Sorghum,	6	23.18	12.38	**17.41**	11.84	7.46	**8.74**	2.00	1.21	**1.55**	64.93	47.65	**56.15**	29.27	22.00	**26.73**	6.83	1:11.85
Common millet,	9	49.29	21.32	**35.42**	12.16	5.43	**7.50**	3.99	2.09	**2.74**	58.61	46.39	**53.89**	33.98	24.88	**30.99**	4.84	-
Japanese millet (white head),	3	26.24	20.95	**24.76**	10.98	7.26	**8.72**	2.64	1.94	**2.33**	50.87	46.71	**49.60**	38.90	30.12	**34.47**	4.88	-
Japanese millet (red head),	6	33.83	22.66	**27.33**	7.99	4.92	**6.90**	2.45	1.58	**2.01**	60.83	50.11	**52.91**	35.29	25.21	**32.10**	6.08	-
White kibi,	2	24.26	22.85	**23.56**	15.14	10.79	**12.97**	1.61	1.50	**1.56**	53.66	52.30	**52.91**	31.70	23.03	**27.37**	5.19	-
Mochi millet,	3	42.29	30.07	**37.42**	11.90	6.11	**9.94**	1.94	1.74	**1.81**	67.08	49.06	**55.69**	29.80	20.01	**25.56**	7.00	-
Mix,	3	31.36	18.17	**24.45**	16.70	9.81	**13.53**	2.48	1.35	**1.86**	52.30	47.75	**51.27**	27.44	26.82	**27.06**	6.28	-
Green oats,	6	55.69	15.51	**25.97**	20.47	7.05	**13.91**	3.95	2.02	**2.89**	50.69	40.42	**44.91**	33.12	25.20	**30.04**	8.25	-
Green rye,	1	-	-	**37.89**	-	-	**5.38**	-	-	**2.46**	-	-	**65.37**	-	-	**21.52**	5.27	-
Green barley,	1	-	-	**20.89**	-	-	**13.16**	-	-	**2.91**	-	-	**42.04**	-	-	**32.72**	8.73	-
Timothy (*Phleum pratense* L.),	2	35.00	34.26	**34.63**	8.83	8.20	**8.52**	2.07	1.95	**2.01**	51.33	51.23	**51.27**	33.23	32.50	**32.87**	5.33	1:12.26
Hungarian grass (*Setaria Italica* Beauv.),	2	25.93	25.69	**25.81**	9.39	9.38	**9.38**	2.43	1.01	**1.72**	57.80	48.01	**52.92**	31.23	24.66	**27.94**	8.04	-
Vetch and oats (one part vetch and nine parts oats),	3	24.04	13.89	**18.97**	10.76	8.83	**10.06**	2.74	2.29	**2.53**	49.85	40.10	**44.75**	35.81	30.77	**33.59**	9.07	1:7.06

Vetch and oats (equal parts of each),	1	-	-	17.98	-	-	16.77	-	-	2.79	-	-	41.33	-	-	29.80	9.31	1:4.46
Barley and peas,	1	-	-	16.09	-	-	13.40	-	-	3.00	-	-	41.79	-	-	33.49	8.32	-
Oats and peas,	2	18.41	13.68	16.04	16.01	14.17	15.09	3.40	2.29	2.84	48.14	40.56	44.36	32.20	26.66	29.43	8.28	-
Horse bean, whole plant (*Vicia faba* L.),	1	-	-	15.17	-	-	16.68	-	-	2.31	-	-	47.09	-	-	28.17	5.75	1:2.71
Soja bean, whole plant (*Soja hispida* Mönch),	10	36.36	18.54	23.58	22.19	13.71	16.45	8.98	2.71	4.84	47.89	40.80	44.50	31.89	21.67	26.47	7.74	1:4.20
Cow-pea vines (*Dolichos sinensis* L.),	3	21.19	18.15	19.63	17.93	11.24	14.59	2.99	1.81	2.48	60.62	46.13	52.42	25.88	21.87	23.59	6.92	1:5.82
Serradella (*Ornithopus sativus* Brot.),	3	19.42	15.40	17.59	17.75	12.17	15.01	2.65	2.09	2.41	46.41	35.45	41.13	38.76	26.21	30.08	10.99	1:3.09
White lupine (*Lupinus albus* L.),	1	-	-	14.65	-	-	18.71	-	-	2.41	-	-	42.67	-	-	31.18	5.03	-
Spanish moss (*Tillandsia usneoides* L.),	1	-	-	39.20	-	-	4.45	-	-	2.54	-	-	57.73	-	-	32.61	2.67	-
II. Hay and Dry Coarse Fodders.																		
English hay (mixed hays),	11	91.94	86.96	89.85	11.93	8.47	9.67	3.18	1.56	2.38	54.72	44.95	49.59	35.55	29.21	32.15	6.21	1:9.55
Rowen of mixed hays,	13	91.16	75.55	82.38	14.70	11.63	12.64	5.03	2.60	3.60	53.52	41.92	49.89	31.50	24.25	26.63	7.24	1:6.76
Timothy hay,	6	92.76	81.26	89.39	9.37	7.24	8.66	2.65	1.95	2.22	54.43	50.01	51.55	36.59	29.21	32.90	4.88	1:11.94
Red-top hay (*Agrostis vulgaris* With.),	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97	1:12.06
Kentucky blue-grass (*Poa pratensis* L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.06	49.61	44.11	46.29	36.84	32.21	34.58	8.35	1:10.38
Orchard grass (*Dactylis glomerata* L.),	4	91.62	90.86	91.17	11.29	7.57	8.99	3.56	2.40	2.91	47.34	43.50	46.15	35.79	34.12	34.89	7.05	1:10.47
Meadow fescue (*Festuca pratensis* Huds.),	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.13	1:13.69
Perennial rye-grass (*Lolium perenne* L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.64	8.14	1:7.40
Italian rye-grass (*Lolium Italicum* A. Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.80	43.09	49.14	36.90	31.27	33.34	7.52	1:10.90
Hungarian grass,	1	-	-	92.55	-	-	9.45	-	-	2.22	-	-	50.64	-	-	31.96	5.73	1:6.22
Barn-yard grass (*Panicum crus-galli* L.),	1	-	-	93.35	-	-	15.27	-	-	1.95	-	-	30.24	-	-	33.72	10.02	1:2.94
Hay of black-grass,	1	-	-	91.25	-	-	6.72	-	-	3.37	-	-	49.47	-	-	31.41	9.03	-

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —													Nutritive Ratio (Average)
					Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.	
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
II. Hay and Dry Coarse Fodders — Continued.																		
Low meadow hay,	1	-	-	91.99	-	-	9.51	-	-	1.88	-	-	46.27	-	-	35.59	6.75	-
Salt hay,	2	91.92	90.34	91.13	4.35	3.77	4.06	3.24	2.65	2.95	60.15	60.14	60.15	27.84	27.82	27.83	5.02	-
Millet,	6	93.85	90.25	92.54	8.88	7.09	7.81	3.63	.89	2.05	55.80	49.62	51.74	35.91	29.80	33.32	5.08	1:7.78
Oats in bloom,	1	-	-	93.57	-	-	6.58	-	-	2.92	-	-	50.03	-	-	34.06	6.41	1:14.23
Oats in milk,	1	-	-	90.45	-	-	10.89	-	-	2.69	-	-	46.02	-	-	34.32	6.08	1:7.90
Oats, ripe,	1	-	-	91.30	-	-	6.05	-	-	2.61	-	-	48.92	-	-	36.31	6.11	1:15.03
Winter rye in bloom,	1	-	-	91.45	-	-	10.66	-	-	2.57	-	-	47.40	-	-	32.97	6.40	1:8.28
Barley in milk,	1	-	-	89.75	-	-	10.26	-	-	2.76	-	-	52.91	-	-	29.12	4.95	1:9.59
Japanese buckwheat,	1	-	-	94.29	-	-	10.80	-	-	2.22	-	-	38.60	-	-	36.02	12.36	-
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	33.75	23.03	29.31	5.14	1:10.98
Corn stover,	26	94.44	75.00	88.18	12.15	5.46	7.29	2.63	1.08	1.38	63.05	44.65	50.82	38.83	20.93	34.84	5.67	1:11.62
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	-	-	93.94	-	-	9.71	-	-	1.28	-	-	53.18	-	-	28.88	6.95	-
Mammoth red clover (*Trifolium medium* L.),	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84	1:5.10
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98	1:5.52
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90	1:3.25
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11	1:4.09

Sand lucerne (*Medicago media* Pers.),	1	-	-	91.20	-	-	16.26	-	-	2.59	-	-	50.31	-	-	21.27	9.57	1 : 3.50
Bokhara clover (*Melilotus alba* Desr.),	2	93.64	91.50	92.57	14.93	11.81	13.37	4.79	1.85	3.32	51.36	38.83	45.08	33.05	28.08	30.57	7.66	-
Blue melilot (*Melilotus cærulea* Desr.),	1	-	-	91.78	-	-	13.81	-	-	1.67	-	-	43.22	-	-	27.17	14.87	-
Sainfoin (*Onobrychis sativa*),	1	-	-	87.83	-	-	17.70	-	-	4.49	-	-	42.27	-	-	26.95	8.54	-
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32	-
Hairy lotus (*Lotus villosus* Thuill),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27	-
Soja bean,	3	93.88	79.91	89.10	19.06	15.10	16.68	8.33	5.62	6.77	51.28	41.09	46.96	25.84	20.76	22.79	6.90	1 : 4.23
Cow-pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29	1 : 4.82
Small pea (*Lathyrus sativus*),	1	-	-	94.20	-	-	16.57	-	-	1.49	-	-	42.76	-	-	32.88	6.30	-
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.23	44.49	48.18	25.92	24.37	25.15	7.09	1 : 4.85
Hairy vetch (*Vicia villosa* Roth.),	1	-	-	92.56	-	-	19.58	-		1.22	-	-	38.95	-	-	31.88	8.37	-
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24	1 : 3.87
Scotch tares,	1	-	-	84.20	-	-	22.00	-	-	1.89	-	-	31.46	-	-	30.89	13.76	-
Vetch and oats,	2	94.22	87.47	90.85	7.72	7.70	7.71	3.37	2.53	2.95	49.95	49.00	49.47	36.22	31.73	33.98	5.89	1 : 11.49
Horse-bean straw,	1	-	-	90.85	-	-	9.69	-	-	1.51	-	-	37.77	-	-	41.44	9.59	1 : 8.55
Soja-bean straw,	2	92.37	87.00	89.68	5.39	5.34	5.36	3.49	1.80	2.64	43.72	43.65	43.70	43.85	36.80	40.32	7.98	-
White daisy (*Chrysanthemum leucanthemum* L.),	1	-	-	90.35	-	-	7.68	-	-	2.32	-	-	46.86	-	-	36.09	7.05	-
Dry carrot tops,	1	-	-	90.24	-	-	20.12	-	-	2.01	-	-	50.39	-	-	13.61	13.87	-
Wheat straw,	1	-	-	93.80	-	-	7.20	-	-	1.63	-	-	50.46	-	-	35.91	4.80	1 : 8.00
Barley straw,	1	-	-	88.56	-	-	9.24	-	-	3.38	-	-	48.23	-	-	33.85	5.30	1 : 26.21
Japanese millet (white head),	1	-	-	91.48	-	-	7.67	-	-	2.41	-	-	49.87	-	-	34.99	5.06	-
Japanese millet (red head),	1	-	-	91.13	-	-	5.76	-	-	1.70	-	-	49.66	-	-	39.52	3.36	-

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.	Nutritive Ratio (Average).
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
II. Hay and Dry Coarse Fodders — Concluded.																		
Straw (*Panicum crus-galli*),	1	-	-	87.35	-	-	6.10	-	-	2.44	-	-	50.20	-	-	35.90	5.36	-
Straw (*P. miliaceum*),	1	-	-	87.83	-	-	3.94	-	-	3.01	-	-	44.72	-	-	42.16	6.17	-
Straw (*P. Italicum*),	1	-	-	80.28	-	-	4.17	-	-	1.59	-	-	46.39	-	-	41.54	6.31	-
III. Roots, Bulbs, Tubers, etc.																		
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58	-
Beets, sugar,	12	19.53	9.87	14.60	17.44	7.32	11.18	.83	.58	.67	81.50	61.93	75.62	9.69	4.82	6.55	5.98	1:7.41
Mangolds,	3	13.08	11.73	12.25	12.84	7.83	10.37	1.01	.73	.88	73.38	70.32	71.75	9.54	7.08	7.94	9.06	-
Beets, yellow fodder,	4	15.01	9.40	11.46	13.96	9.29	11.69	2.02	.84	1.39	75.22	61.90	69.33	9.66	7.26	8.14	9.45	-
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75	1:11.83
Turnips,	3	12.80	8.22	9.79	10.81	9.67	10.12	2.05	1.42	1.74	70.62	65.91	68.44	12.61	10.12	11.23	8.47	1:13.26
Carrots,	4	12.52	9.95	10.72	9.63	7.98	8.93	3.94	1.67	2.34	73.96	67.24	71.27	10.76	7.55	9.19	8.27	1:9.67
Parsnips,	1	-	-	19.66	-	-	6.88	-	-	3.37	-	-	74.65	-	-	-	7.67	-
Potatoes,	10	21.95	13.91	18.78	13.56	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.55	1.91	2.75	5.26	1:12.25
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08	1:26.44

IV. Grains and Other Seeds.																		
Corn kernels,	29	91.98	65.50	**89.43**	15.02	8.49	**12.18**	9.43	4.25	**5.42**	83.98	71.06	**78.49**	3.38	1.03	**2.12**	1.69	1:8.16
Sweet corn kernels,	1	-	-	**88.02**	-	-	**12.57**	-	-	**9.56**	-	-	**73.83**	-	-	**2.41**	1.63	-
Corn and cob meal,	37	94.00	80.89	**89.47**	15.06	7.82	**10.01**	5.27	3.36	**4.19**	81.41	70.13	**76.62**	10.41	5.63	**7.54**	1.64	-
Wheat kernels,	1	-	-	**89.42**	-	-	**13.35**	-	-	**1.79**	-	-	**80.20**	-	-	**2.42**	2.18	1:6.42
Broom corn seed,	1	-	-	**85.90**	-	-	**11.21**	-	-	**4.05**	-	-	**74.05**	-	-	**8.34**	2.35	-
Soja beans,	3	94.15	80.73	**85.83**	35.98	32.58	**33.97**	21.89	18.42	**20.19**	34.88	32.87	**33.98**	7.57	5.15	**6.02**	5.84	1:2.61
Horse beans,	1	-	-	**89.72**	-	-	**30.03**	-	-	**1.11**	-	-	**56.48**	-	-	**8.11**	4.27	1:2.24
Red adzinki beans,	2	85.18	83.10	**84.14**	25.14	23.75	**24.45**	.88	.76	**.82**	66.48	65.41	**65.95**	4.68	4.50	**4.59**	4.19	-
Saddle beans,	1	-	-	**87.62**	-	-	**15.12**	-	-	**16.58**	-	-	**57.34**	-	-	**4.75**	6.21	-
Daidzu beans,	1	-	-	**88.47**	-	-	**38.99**	-	-	**18.59**	-	-	**30.41**	-	-	**4.97**	7.04	-
Millet seed,	3	87.32	86.11	**86.65**	14.60	11.76	**13.24**	4.94	3.53	**4.32**	73.19	66.94	**70.56**	10.23	6.48	**8.88**	3.00	-
Chestnuts,	1	-	-	**55.14**	-	-	**13.32**	-	-	**14.46**	-	-	**67.05**	-	-	**2.45**	2.72	-
V. Flour and Meal.																		
Corn meal,	29	89.95	82.96	**86.39**	16.08	9.73	**11.07**	5.08	3.10	**4.49**	83.24	73.20	**80.59**	3.60	1.20	**2.15**	1.58	-
Hominy meal,	4	-	-	**90.00**	4.15	3.00	**3.57**	.67	.38	**.57**	63.62	60.58	**61.78**	33.77	31.36	**32.93**	1.21	1:30.85
Ground barley,	4	89.09	82.59	**86.44**	14.93	10.42	**12.46**	2.38	1.69	**2.10**	78.25	74.47	**76.83**	7.37	4.10	**5.84**	2.77	-
Broom-corn meal,	1	-	-	**86.46**	-	-	**11.14**	-	-	**4.13**	-	-	**74.30**	-	-	**8.00**	2.43	-
Pea meal,	1	-	-	**91.15**	-	-	**20.95**	-	-	**1.67**	-	-	**55.02**	-	-	**19.42**	2.94	-
Bean meal,	1	-	-	**88.02**	-	-	**12.57**	-	-	**9.56**	-	-	**73.83**	-	-	**2.41**	1.63	-
Millet meal (*Panicum Italicum*),	1	-	-	**89.38**	-	-	**35.12**	-	-	**17.35**	-	-	**38.95**	-	-	**3.86**	4.72	-

A. Analyses of Fodder Articles — Concluded.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.	Nutritive Ratio (Average).
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.		
VI. By-products and Refuse.																		
Linseed cake, old process,	7	92.52	88.50	**90.54**	39.97	30.98	**36.64**	9.87	6.24	**7.16**	44.72	37.76	**40.61**	9.69	8.04	**8.68**	6.91	1:1.66
Linseed cake, new process,	5	94.94	88.17	**92.05**	41.02	35.03	**39.18**	4.08	2.17	**3.12**	46.49	40.83	**41.87**	10.31	8.93	**9.38**	6.45	1:1.32
Cotton-seed meal, decorticated,	19	94.31	88.81	**91.69**	51.79	36.54	**44.21**	14.72	9.47	**12.26**	35.84	20.22	**28.04**	10.83	5.87	**7.94**	7.55	-
Wheat bran,	35	92.58	86.30	**89.51**	20.54	15.67	**17.78**	6.08	2.80	**5.00**	62.18	51.77	**59.32**	14.26	7.49	**10.89**	7.01	-
Wheat middlings,	6	90.75	87.57	**89.93**	19.21	15.13	**16.72**	6.46	3.19	**5.31**	74.30	58.03	**61.77**	11.21	1.40	**9.21**	6.99	1:4.21
Rye bran,	2	91.82	86.30	**89.06**	18.98	16.52	**17.75**	3.03	2.07	**2.55**	73.56	69.24	**71.70**	4.54	3.46	**4.00**	4.30	1:4.88
Rye middlings,	1	-	-	**87.46**	-	-	**13.15**	-	-	**5.61**	-	-	**73.52**	-	-	**3.70**	4.02	1:7.28
Buckwheat middlings,	1	-	-	**88.49**	-	-	**25.49**	-	-	**7.53**	-	-	**66.36**	-	-	**5.18**	5.44	-
Gluten meal,	26	93.50	68.32	**90.65**	39.28	25.75	**31.42**	12.05	3.92	**8.18**	66.26	48.26	**57.48**	6.39	.41	**2.14**	.78	-
Maize feed,	3	91.40	90.25	**90.95**	29.40	21.33	**25.47**	7.90	6.15	**6.96**	62.12	53.85	**58.27**	9.65	7.93	**8.53**	.77	-
Corn germ meal,	1	-	-	**90.65**	-	-	**28.26**	-	-	**11.82**	-	-	**42.49**	-	-	**9.18**	8.25	-
Corn germ feed,	1	-	-	**92.45**	-	-	**10.81**	-	-	**12.17**	-	-	**62.10**	-	-	**14.05**	.87	-
Corn screenings,	1	-	-	**88.98**	-	-	**8.29**	-	-	**4.48**	-	-	**81.57**	-	-	**3.27**	2.39	-
Oat feed,	1	-	-	**90.66**	-	-	**14.06**	-	-	**8.23**	-	-	**66.52**	-	-	**8.79**	4.40	-
Cocoanut meal,	1	-	-	**90.67**	-	-	**22.61**	-	-	**12.88**	-	-	**40.03**	-	-	**18.80**	5.68	-
Bakery refuse,	1	-	-	**86.66**	-	-	**9.23**	-	-	**6.36**	-	-	**72.34**	-	-	**.43**	11.64	-

Vinegar mash,	1	-	-	5.51	-	-	16.50	-	-	8.45	-	-	63.47	-	-	8.55	3.03	-
Refuse from starch works,	1	-	-	42.96	-	-	22.41	-	-	10.17	-	-	58.98	-	-	7.54	.90	-
Spent brewers' grain,	4	93.02	88.00	90.13	33.16	16.08	23.29	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53	1:2.90
Malt sprouts,	1	-	-	84.63	-	-	27.17	-	-	3.85	-	-	47.92	-	-	14.75	6.31	-
Cocoa dust from cocoa manufactory,	1	-	-	92.90	-	-	15.47	-	-	25.85	-	-	45.99	-	-	5.86	6.83	-
Broom-corn waste,	1	-	-	91.30	-	-	6.78	-	-	1.00	-	-	48.09	-	-	39.25	4.88	-
Cotton hulls,	2	89.83	88.55	89.10	5.36	4.90	5.13	4.27	2.36	3.31	46.75	38.59	42.67	51.40	40.24	45.82	3.07	1:28.16
Apple pomace,	2	21.78	17.22	19.50	7.73	6.94	7.34	4.37	3.17	3.78	72.93	70.20	72.56	16.58	13.15	14.86	1.46	-
Apple pomace ensilage,	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21	-
Sugar beet pulp from diffusion battery,	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04	-
Corn cobs,	6	94.05	90.00	92.35	4.15	1.46	2.91	.77	.38	.56	63.62	58.78	61.21	37.84	31.36	33.96	1.36	-
Palmetto root,	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.95	-	-	21.26	4.44	-

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	$1 65
Fodder corn ensilage,	2	77.95	.278	-	.368	.050	.100	.090	.020	.113	.040	1 29
Corn and soja bean ensilage,	1	71.03	.790	-	.444	-	-	-	-	.420	-	3 23
Sorghum,	7	82.19	.233	-	.229	.025	.076	.075	.012	.088	.136	1 00
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	1 79
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 50
Mix,	3	75.59	.499	1.54	.363	.060	.249	.245	.021	.237	.527	2 08
Green oats,	3	83.36	.489	1.31	.381	.217	.154	.134	.018	.130	.496	1 95
Green rye,	1	62.11	.326	-	.734	-	-	-	-	.150	-	1 80
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 53
Horse bean,	1	74.71	.675	-	1.370	.090	1.370	.620	.200	.330	2.040	3 62
Soja bean,	1	73.20	.292	-	.531	-	-	-	-	.151	-	1 61
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 21
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	1 77
Hungarian grass,	1	74.31	.386	-	.549	-	-	-	-	.159	-	1 87

White lupine,	1	85.35	.440	-	1.730	.680	3.070	.730	.170	.350	.900	3 26
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 10
II. Hay and Dry Coarse Fodders.												
English hay,	9	11.99	1.409	6.34	1.550	.110	.344	.240	.021	.269	.980	$5 92
Rowen,	12	18.52	1.609	9.57	1.486	.140	.640	.280	.034	.432	1.840	5 64
Timothy hay,	3	11.26	1.240	4.93	1.460	.180	.620	.120	.006	.342	1.000	5 41
Red-top,	4	7.71	1.150	4.59	1.020	.438	.571	.134	.036	.360	1.736	4 76
Kentucky blue-grass,	2	5.34	1.320	-	1.694	.129	.398	-	.044	.431	2.863	5 95
Orchard grass,	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	6 08
Meadow fescue,	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	5 30
Perennial rye-grass,	2	9.13	1.227	6.79	1.553	.307	.642	.337	.044	.559	2.262	5 69
Italian rye-grass,	4	8.71	1.189	-	1.273	.451	.857	.321	.071	.556	2.598	5 32
Salt hay,	1	5.36	1.180	-	.718	.017	.371	.335	.028	.248	-	4 46
Japanese millet (white head),	3	10.45	1.105	5.80	1.223	.012	.465	.377	.028	.403	1.033	4 86
Japanese buckwheat,	1	5.72	1.629	-	3.320	.349	3.418	.421	.148	.852	.378	8 81
Fodder corn,	7	7.85	1.763	4.91	.889	.175	.605	.500	.075	.542	1.270	6 69
Corn stover,	16	9.12	1.043	3.74	1.400	.112	.622	.384	.068	.293	1.885	4 71
Teosinte,	1	6.06	1.460	6.53	3.696	.109	1.597	.458	.021	.546	.315	8 31
Millet hay,	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.490	1.360	5 90
Mammoth red clover,	3	11.41	2.231	8.72	1.223	.389	3.141	.613	.111	.546	.779	8 39

* The valuation is based on the following prices per pound of the essential fertilizing ingredients: Nitrogen, 15 cents; potassium oxide, 4½ cents; phosphoric acid, 5½ cents.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
Medium red clover,	2	7.91	2.184	8.36	2.286	.210	1.689	.402	.099	.447	.919	$9 10
Alsike clover,	6	9.94	2.342	11.11	2.227	.309	2.153	.537	.197	.668	1.776	9 77
Lucerne (alfalfa),	4	6.26	2.075	6.82	1.461	.814	2.211	.406	.078	.526	.513	8 12
Bokhara clover,	2	7.43	1.975	7.70	1.832	.114	1.784	.347	.023	.558	.057	8 19
Blue melilot,	1	8.22	1.919	13.65	2.796	.270	1.449	.260	.349	.544	4.008	8 87
Sainfoin,	1	12.17	2.630	7.55	2.020	.540	1.160	.430	.040	.760	.470	10 54
Sulla,	2	9.39	2.460	–	2.093	.223	2.497	.350	.114	.453	.614	9 76
Lotus villosus,	2	11.52	2.095	8.23	1.807	.499	2.220	.476	.112	.594	.976	8 56
Soja bean,	2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.667	.977	8 66
Cow-pea,	1	9.00	1.635	8.40	.913	.122	2.696	.688	.046	.527	.832	6 31
Small pea,	1	5.80	2.497	–	1.990	.469	1.373	.276	.138	.592	1.081	9 93
Serradella,	2	7.39	2.697	10.60	.652	.656	2.545	.461	.066	.777	.590	9 83
Scotch tares,	1	15.80	2.964	–	3.004	.238	1.698	.354	.460	.815	4.062	12 49
Vetch and oats,	3	9.91	1.299	9.58	1.349	.420	.663	.265	.098	.560	.521	5 72
Soja-bean straw,	1	13.00	.750	–	1.322	–	.436	.469	.035	.397	.218	3 88
White daisy,	1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	2 44

Dry carrot tops,	1	9.76	3.130	12.52	4.883	4.028	2.089	.667	.118	.612	.098	14 46
Barley straw,	1	11.44	1.310	5.30	2.086	.183	.572	.180	–	.303	2.380	6 14
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	7	87.73	.243	1.13	.436	.091	.049	.033	.004	.091	.020	$1 22
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.048	1 21
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	1 09
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 01
Ruta-bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 15
Turnips,	2	89.49	.178	1.01	.385	.078	.089	.027	.009	.104	.055	0 99
Carrots,	2	89.79	.147	9.22	.506	.062	.067	.023	.009	.093	.019	1 00
Parsnips,	1	80.34	.217	–	.617	.006	.088	.045	.005	.187	.019	1 41
Potatoes,	1	79.75	.207	.99	.294	.013	.007	.020	.002	.066	.006	0 96
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57
IV. Grain and Other Seeds.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	$6 60
Corn and cob meal,	29	8.96	1.409	–	.472	.059	.018	.176	.011	.571	.430	5 28
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	19 75
Red adzinki beans,	1	14.82	3.240	–	1.540	.035	.090	.210	.180	.940	.050	12 14
White adzinki beans,	1	16.90	3.330	–	1.480	.190	.130	.220	.021	.970	.130	12 39
Saddle beans,	1	12.38	2.120	–	2.130	.020	.250	.430	.032	1.520	.250	9 95
Daidzu beans,	1	11.53	5.520	–	1.960	.210	.220	.400	.050	1.480	.280	19 95

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
IV. Grain and Other Seeds — Concluded.												
Japanese millet,	2	13.68	1.730	-	.380	.030	.045	.225	.015	.685	-	$6 22
Common millet,	1	12.68	2.040	-	.360	.060	.040	.260	.030	.850	.143	7 38
Chestnuts,	1	44.86	1.175	2.72	.632	-	.060	.135	.010	.392	.069	4 53
V. Flour and Meal.												
Corn meal,	2	13.52	2.050	1.42	.435	.064	.034	.187	.015	.707	.005	$7 31
Hominy feed,	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	6 41
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.669	5 68
Wheat flour,	1	9.83	2.210	1.22	.540	-	.170	.050	-	.570	-	7 74
Pea meal,	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	11 04
VI. By-products and Refuse.												
Linseed cake, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	$19 22
Linseed cake, new process,	4	7.35	5.808	5.04	1.288	.823	.663	.655	.062	1.628	.345	20 37
Cotton-seed meal,	9	8.96	6.467	6.49	1.723	.291	.587	.589	.020	2.333	.457	23 52
Wheat bran,	5	11.39	2.879	6.44	1.625	.159	.168	.899	.019	2.845	.141	13 23
Wheat middlings,	1	9.18	2.630	2.30	.630	.110	.200	.210	-	.950	-	9 50

Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.320	.020	1.260	.170	7 63
Gluten meal,	5	8.53	5.090	.65	.047	.018	.050	.035	.009	.420	-	15 77
Spent brewers' grain,	2	8.58	2.680	6.15	.853	.347	.296	.286	.159	1.045	1.770	9 96
Cocoa dust,	1	7.10	2.299	6.35	.630	-	.630	-	-	1.340	-	8 94
Broom corn waste (stalks),	1	10.37	.870	4.70	1.858	-	.242	.170	-	.460	1.000	4 79
Cotton hulls,	3	10.63	.750	2.61	1.080	-	.200	.260	-	.180	.060	3 42
Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	0 82
Corn cobs,	8	12.09	.504	.815	.598	.071	.025	.045	.009	.063	.190	2 12
Palmetto roots,	1	11.51	.540	3.93	1.380	.345	.045	.004	.017	.157	.410	3 03
Buckwheat hulls,	1	11.90	.490	-	.521	-	.247	.236	.020	.073	.066	2 02

C. Analyses of Fruits.

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	-	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Rhode Island Greening, . .	Sept. 1,	20.27	1.055	12—15	3.16	-	-	-
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Rhode Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Pear (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Pear (Bartlett),‡ . . .	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Cranberries, ...	-	10.71	1.025	15	1.35	-	-	-§
Cranberries, ...	1878.	10.11	1.025	15	1.70	-	-	-‖
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Crawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Crawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Crawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.
† Picked October 9.
‡ Picked September 7.
§ Free acid, 2.25 per cent.
‖ Free acid, 2.43 per cent.
¶ In pulp, kept ten days before testing.

C. Analyses of Fruits — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord, ...	July 17,	1.0175	31	8.30	.645	7.77	-
Concord, ...	July 20,	1.0150	31	8.10	.625	7.72	216
Concord, ...	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord, ...	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord, ...	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord, ...	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord, ...	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape, . . .	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape, . . .	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape, . . .	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape, . . .	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape, . . .	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific, ...	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' seedling, ...	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona, ...	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed), ...	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam, ...	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder, ...	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware, ...	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak, ...	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella, ...	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling, ...	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack, ...	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba, ...	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder, ...	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak, ...	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord, ...	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord, ...	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan, ...	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape, . . .	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled), .	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled), .	Sept. 20,	1.045	16	16.69	8.22	49.25	104

* One part of pure Na_2CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled,	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled,	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled,	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled,	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled,	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled,	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled,	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled,	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
Iona, not girdled,	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled,	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled,	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled,	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled,	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled,	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled,	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled,	Oct. 5,	1.085	12	–	17.86	–	54

	Date.	100 Parts of Grapes contained — Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled,	Sept. 23,	–	84.69	6.24	.75
Concord, girdled,	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled,	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled,	Oct. 8,	.37	82.69	8.50	.50
	1890.				
Concord, not girdled,	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled,	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled,	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled,	Oct. 9,	.59	85.11	6.65	.51
Concord, girdled,	Oct. 9,	.54	85.15	9.12	.74

* One part of pure Na_2CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	–	–	8.03	–	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	–	–	13.51	–	Fertilized.
Wild Purple Grape Juice, .	"	–	1.045	16	8.22	9.840	Unfertilized.
Wild Purple Grape Juice, .	"	–	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	–	–	–	–	Unfertilized.
Wild White Grape Berries, .	"	21.65	–	–	–	–	Fertilized.
Wild White Grape Juice, .	"	–	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, .	"	–	–	–	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	–	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.

C. Analyses of Fruits — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED —						
		Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit),	–	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice,	–	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice,	–	40.69	–	6.85	6.24	–	9.04	–
Skins and pulp,	–	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds,	3.08	6.71	–	–	3.03	–	17.20	.29
Stems of grapes,	4.69	20.91	–	20.20	8.45	–	17.75	2.09
Young branches,*	–	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,†	2.97	22.57	–	9.72	4.28	–	14.07	23.84
Concord Grapes, 1891,‡	.55	49.76	–	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit),	–	58.45	3.51	13.34	7.37	.90	18.19	–
Baldwin Apple,	–	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),‖	–	58.47	–	14.64	6.12	3.37	17.40	–
Strawberry vines,	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit),	.18	47.96	6.58	18.58	6.78	–	14.27	–
Cranberry vines,	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red,	.47	47.68	4.02	18.96	6.23	1.20	21.91	–
Currants, white,	.59	52.79	3.00	17.08	5.68	2.67	18.78	–
Crawford Peach, sound,	–	74.46	–	2.64	6.29	.58	16.02	–
Crawford Peach, diseased,¶	–	71.30	–	4.68	5.49	.46	18.07	–
Branch, sound,	–	26.01	–	54.52	7.58	.52	11.37	–
Branch, diseased,¶	–	15.67	–	64.23	10.28	1.45	8.37	–
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems,	–	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots,	–	56.43	5.42	15.48	7.57	–	15.09	3.67
Onions,	–	38.51	1.90	8.20	3.65	.58	15.80	3.33

* With tendrils and blossoms.
† One year old.
‡ Nitrogen in dry matter, .96 per cent.
§ Wilder.
‖ Downing.
¶ Yellows.
** Nitrogen in dry matter, 1.15 per cent.

D. Analyses of Sugar-producing Plants.

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, ...	Sept. 10,	14	12.30	1.75
Imperial, ...	" 12,	15	12.59	2.41
Vilmorin, ...	" 13,	14.5	12.95	1.55
Imperial, ...	" 18,	14	10.79	3.21
Imperial, ...	Oct. 11,	15	12.05	2.95
Electoral, ...	" 16,	15	12.22	2.78
Vilmorin, ...	" 18,	16	13.13	2.87
Imperial, ...	Nov. 14,	15	11.60	3.34
Vilmorin, ...	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept. 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, ...	Saxony, .	$\frac{3}{4}$ to $\frac{7}{8}$	15.50
II. Vilmorin, ...	Saxony, .	$\frac{3}{4}$ to 1	15.61
I. White Imperial, ...	Saxony, .	$\frac{3}{4}$ to $1\frac{3}{4}$	14.20
II. White Imperial, ...	Saxony, .	$1\frac{3}{4}$ to 2	10.27
New Imperial, ...	Saxony, .	$1\frac{1}{4}$ to $1\frac{3}{4}$	13.80
I. White Magdeburg, . . .	Saxony, .	$1\frac{1}{2}$ to 2	13.10
II. White Magdeburg, . . .	Silesia, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	10.06
Quedlinburg, ...	Saxony, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	13.44
White Silesian, ...	Silesia, .	$1\frac{1}{4}$ to $1\frac{1}{2}$	9.72

D. Analyses of Sugar-producing Plants — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam, .	Fresh yard-manure, .	16.5	12.50	4.00	75.08
Clayish loam, .	Fresh yard-manure, .	15.5	11.05	4.45	71.30
Warm alluvial, .	Yard-manure and chemicals, . . .	12.75	9.17	3.58	71.92
Warm alluvial, .	Fresh hog-manure, .	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure, . . .	18.5	13.73	4.77	74.21
Alluvial soil, .	Brighton fish, . .	14.5	11.15	3.35	76.90
Heavy soil, .	Yard-manure, . .	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure, ...	11.96	9.42	7.80
Blood guano without potash, . .	10.99	10.10	10.20
Blood guano with potash, . . .	12.55	13.24	10.50
Kainite and superphosphate, . .	13.15	12.16	10.50
Sulphate of potash, ...	14.52	14.32	12.78
Second year after stable-manure, .	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college).

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

Locality of Beet-field.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y.,	1872–73	11	7.80	3.20
2. Washington, N. Y.,	"	14	10.97	3.03
3. South Hartford, N. Y.,	"	15	11.70	3.30
4. Greenwich, N. Y.,	"	12	9.50	2.50
5. Frankfort, N. Y.,	"	13.5	11.00	2.50
6. Albion, N. Y.,*	"	18	15.10	2.90
Albion, N. Y.,†	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

Where Grown.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal,	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup,	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly,	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge,	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

DATE.	CONDITION OF CANE.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15,	No flower stalks in sight,* . . .	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight,* . . .	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,* . . .	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,* . . .	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,* .	13.2	22	3.57	7.65	–	–
Sept. 18,	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21,	Juice from the above,* . . .	13.0	21	–	–	–	–
Sept. 23,	Juice from the above,* . . .	15.0	18	–	–	–	–
Sept. 25,	Left on field 3 weeks,† . . .	19.8	21	11.91	6.27	–	–
Sept. 28,	Left on field 3 weeks,† . . .	17.8	12	16.60	–	–	–
Oct. 4,	Left on field 3 weeks,† . . .	16.1	17	8.62	6.16	12.0	–
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14,	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18,	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19,	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22,	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23,	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24,	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 PARTS OF CANE CONTAINED —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	Grown on station grounds.
October,	Price's new hybrid, ripe, . . .	77.80	2.92	3.78	6.70	
October,	Kansas orange, green, ...	80.67	2.38	3.63	6.01	
October,	New orange, green, ...	78.30	2.96	3.85	6.81	
October,	Honduras, green, ...	77.55	3.08	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,† . . .	1.052	–	4.85	5.70	20.38
Common sweet corn,‡ . . .	1.035	–	6.60	None.	–
Common yellow musk-melon,§ .	1.040	26	1.67	2.65	–
White-flesh water-melon, . .	1.025	18	2.91	2.16	–
Red-flesh water-melon, . . .	1.025	22	3.57	2.18	–
Red-flesh water-melon, . . .	1.025	19	3.84	1.77	–
Nutmeg musk-melon,‖ . . .	1.030	19	3.33	2.11	–
Nutmeg musk-melon,¶ . . .	1.050	20	2.27	5.38	–
Nutmeg musk-melon,** . .	1.030	19	2.50	1.43	–

* Tassels appearing.
† Ears ready for the table.
‡ Kernels somewhat hard.
§ Fully ripe.
‖ Not ripe.
¶ Ripe.
** Over-ripe.

E. Analyses of Dairy Products.

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk,	1,401	18.27	10.58	13.44	7.54	2.48	4.06	-	-	3.20	-	-	-	.70
Skim milk,	303	10.40	7.68	9.49	1.02	.20	.40	-	-	3.53	-	-	-	.80
Buttermilk,	24	9.86	7.40	8.19	.38	.15	.27	-	-	2.79	-	-	-	.80
Cream (from Cooley Creamer),	121	29.35	21.30	25.35	20.90	13.74	17.40	-	-	-	-	-	-	.62
Butter,	25	92.89	87.05	89.11	89.05	81.43	83.95	.89	.51	.66	6.45	3.46	4.74	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.99	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

* From analyses made in 1875.

E. Salt for Meat Packing and Dairy Purposes.

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Pettite Anse, La.,	.330	98.882	.782	.004	.003	–	–	–	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	–	.090	.070	.070	–	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	–	–	–	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	–	–	–	
Solar salt, Saginaw Valley, Mich.,	3.314	95.813	.316	.356	.140	–	–	–	
Solar salt from Kansas,	4.950	93.060	1.220	–	.240	.350	.180	–	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	–	.080	.390	None.	–	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	–	–	–	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	–	–	–	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	–	.614	.041	–	–	–	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	–	.060	–	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	–	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	–	–	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	–	–	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	–	–	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	–	–	.072	
Ashton salt (sent on),	.760	97.650	1.430	–	.060	–	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	–	–	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	–	–	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	–	–	.700	
Royal salt,	.880	97.877	1.108	.016	.010	–	–	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	–	–	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	–	–	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	–	–	–	
Bradley salt,	.200	98.575	1.185	.029	.007	–	–	–	
Higgins' Eureka salt,	.855	98.891	.906	.293	.055	–	–	–	
Worcester refined salt,	.565	97.935	1.376	.097	.027	–	–	–	

F. Analyses of Insecticides.

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
Paris green,	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green,	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green,	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green,	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green,	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green,	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green,	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green,	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor,	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

METEOROLOGY.

1892.

The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness are recorded each day at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same times. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the signal service at Washington, D. C., and to the New England Meteorological Society. During the summer months partial monthly reports have been furnished also for the use of the secretary of the State Board of Agriculture.

At the beginning of the year there was no snow on the ground. After January 1 the total snowfall of the season amounted to thirty-four inches. The heaviest snow-storm during that time occurred on January 15, measuring seven inches. A storm giving six inches of snow occurred on February 11. The last storm, which was only a trace, fell on April 10.

The last frost of the season was on May 10, when the minimum thermometer registered 35° F.

The mean temperature during the first four months was 31.43° F., being a little over one degree lower than that of last year. The absolute minimum temperature was — 10°, occurring on January 15.

The mean monthly range for the four months was 18.84° F., being 14.16° lower than that of the first four months of 1891. The prevailing wind was N. N. E. for January and February,

and N. W. for March and April. During the following four months, May, June, July and August, the mean temperature was 65.32° F., being 1.67° lower than that of the corresponding months of last year, while the mean range of temperature was 5° greater.

The absolute maximum temperature, viz., 94.5°, occurred on June 14. The minimum temperature was 30°, occurring on May 1. The cold wave in May was unfavorable to the germination of seeds, and was a set-back to general farming operations.

The total precipitation during the months of May, June, July and August was 17.97 inches. During the months of June and July the precipitation was slightly below the normal, and there were extreme ranges of temperature. The month of August was characterized by excessive rainfalls, the precipitation being much above the normal, and 2.03 inches more than that for August, 1891.

The month of September was very fair and pleasant, being free from severe storms, and there was no frost until the 30th, which was the first of the season. The precipitation was far below the normal. The prevailing wind was S. The temperature for October and November was about normal, while for December it was much below.

The precipitation for October and December was exceedingly small, but for November was above the normal. The total amount of snowfall during the month of November was 2.68 inches, and for December 2.75 inches. The first trace of snow for the season fell November 5. The total amount of precipitation during the year was below the normal, and was unevenly distributed. The largest amount of water falling in one month was 5.70 inches, — August; the smallest amount, 0.64 of an inch, in October; and only 0.65 of an inch fell in April, being an exceedingly small figure for that month.

Summary of Meteorological Observations, 1892.

	Temperature, Degrees Fahrenheit.														
	7 A.M.	2 P.M.	9 P.M.	Mean.	Maximum.	Minimum.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	Greatest Daily Range.	Date.	Least Daily Range.	Date.	Mean Daily Range.
January,	19.03	28.68	23.29	23.55	33.27	13.82	55.0	2d, 14th	—10.0	17th	37.0	26th	5.0	13th	19.45
February,	19.90	31.52	25.65	25.69	30.80	16.59	46.5	26th	—8.0	18th	52.0	18th	3.0	3d	14.21
March,	25.30	37.00	30.70	31.00	39 60	22.20	59.0	26th	5.0	22d	34.0	31st	7.0	1st	17.40
April,	40.30	54.20	43.80	45.50	57.40	33.10	76.0	5th	22.0	25th	40.0	20th	11.0	29th	24.30
May,	50.40	61.80	53.80	55.00	64.04	43.90	81.0	31st	30.0	1st	35.0	18th	6.0	21st	20.14
June,	64.40	77.40	66.60	68.77	80.03	58.40	94.5	14th	40.5	11th	38.5	11th	9.0	27th	21.60
July,	64.84	79.50	67.24	69.75	82.00	59.50	92.0	26th, 28th, 29th	42.0	17th	34.0	21st	10.0	1st	22.50
August,	63.34	76.29	65.74	67.78	78.61	58.00	90.0	10th	51.5	15th, 16th	31.5	18th	7.0	27th	20.61
September,	52.30	69.90	57.70	59.30	71.60	46.51	79.0	18th, 19th, 25th	34.0	30th	41.0	31st	8.0	14th, 24th	25.08
October,	43.63	59.45	48.47	50.00	61.57	36.56	70.0	8th, 16th	23.5	25th	35.0	13th	11.0	17th	25.01
November,	34.25	42.27	36.67	37.46	45.77	29.00	66.0	18th	14.5	24th	29.5	7th	6.5	10th	16.80
December,	21.57	32.01	23.95	26.35	34.73	17.74	55.0	12th	—1.0	27th	31.0	27th	4.5	14th	6.99
Sums,	499.26	650.02	543.61	560.15	679.42	435.32	864.0	-	244.0	-	438.5	-	88.0	-	234.09
Mean,	41.61	54.17	45.30	46.68	56.62	36.28	72.0	-	20.33	-	36.5	-	7.3	-	19.51

1892.	Precipitation, Inches.					Mean Dew Point.	Relative Humidity. Per Cent.				Wind.	Character of Days.		
	Total Amount.	Date of Greatest Fall.	Total Snowfall.	Depth of Snow the 15th.	Depth of Snow at End of Month.		7 A.M.	2 P.M.	9 P.M.	Mean.	Prevailing Direction.	Clear.	Fair.	Cloudy.
January, . . .	5.05	2d	13.00	8.50	2.00	-	-	-	-	-	N. NE.	9	7	15
February, . .	1.59	3d	14.00	15.00	2.00	-	-	-	-	-	N. NE.	8	12	9
March, . . .	2.45	23d	7.00	-	-	-	-	-	-	-	N. W.	14	10	7
April, . . .	0.65	21st	-	-	-	-	-	-	-	-	N. W.	12	14	4
May, . . .	5.49	21st	-	-	-	-	-	-	-	-	S. W.	4	11	16
June, . . .	3.04	23d	-	-	-	60.0	87	56	82	75	S. W.	7	10	13
July, . . .	3.74	30th	-	-	-	61.2	81	60	81	74	S. W.	19	7	5
August, . . .	5.70	27th	-	-	-	62.3	90	66	90	82	N.	12	15	4
September, . .	1.53	15th	-	-	-	50.6	72	62	83	72	S.	22	3	5
October, . . .	0.64	9th	-	-	-	-	-	-	-	-	N.	16	8	7
November, . .	4.28	16th	2.68	-	-	-	-	-	-	-	N. W.	8	9	13
December, . .	1.05	8th	2.75	-	-	-	-	-	-	-	N. W.	10	16	5
Sums, . .	35.21	-	39.43	-	-	-	-	-	-	-	-	141	122	103
Mean, . .	2.93	-	-	-	-	-	-	-	-	-	-	-	-	-

Casual Phenomena. — Dates.

1892.	Thunder-storms.	Solar Halos.	Lunar Halos.	Aurora.
January, . .	- -	10,	10,	5.
February, .	- -	19,	10,	13, 23, 26.
March, . .	- -	5, 16, 17, 22,	17,	6, 24, 25.
April, . .	- -	3, 5, 7, 8, 14, 15, 25,	3, 5, 7,	23, 24, 25, 26, 29.
May, . .	4,	1, 4, 5, 17, 26,	-	18.
June, . .	14, 17, 23, 30,	8, 10, 11, 13, 14, 29,	-	- -
July, . .	3, 13, 14, 16, 22, 23, 26, 28, 29,	22, 24,	4, 5,	- -
August, . .	4, 9, 11, 12, 19, 20, 26,	- -	6,	- -
September, .	26,	4, 10, 19, 21,	3,	- -
October, . .	- -	15, 20,	-	- -
November, .	- -	9, 29,	8,	4.
December, .	- -	16, 20, 31,	27, 31,	- -

January, February, March, April.

	1891.	Date.	1892.	Date.
Mean temperature,	33.20°	-	31.43°	-
Absolute maximum temperature,	77.00°	April 30,	76.00°	April 5.
Absolute minimum temperature,	—5.50°	Feb. 15,	—10.00°	Jan. 17.
Mean monthly range,	33.00°	-	18.84°	-
Total precipitation (inches),	16.08	-	9.74	-
Total snowfall (inches),	58.00	-	34.00	-
Last snowfall,	-	April 3,	-	April 10.
Prevailing wind,	N. E.	-	N. E. & N. W.	-

May, June, July, August.

	1891.	Date.	1892.	Date.
Mean temperature,	63.65°	-	65.32°	-
Absolute maximum temperature,	90.00°	Aug. 11,	94.50°	June 14.
Absolute minimum temperature,	25.00°	May 1,	30.00°	May 1.
Mean monthly range,	25.25°	-	21.21°	-
Last frost,	-	June 25,	-	May 10.
Total rainfall (inches),	15.16	-	17.97	-
Prevailing wind,	N. E	-	S.W.	-

September, October, November, December.

	1891.	Date.	1892.	Date.
Mean temperature,	46.00°	-	43.28°	-
Absolute maximum temperature,	89.00°	Sept. 18,	79.00°	Sept. 18, 19, 25.
Absolute minimum temperature,	4.00°	Nov. 30,	—1.00°	Dec. 27.
Mean monthly range,	35.05°	-	18.47°	-
First frost,	-	Oct. 10,	-	Sept. 30.
Total precipitation (inches),	11.31	-	7.50	-
First snowfall,	-	Nov. 26,	-	Oct. 5.
Total snowfall (inches),	1.50	-	5.43	-
Prevailing wind,	S. E.	-	N. W.	-

Entire Year.

	1891.	Date.	1892.	Date.
Mean temperature,	47.62°	-	45.68°	-
Total precipitation (inches),	42.58	-	35.21	-
Total snowfall (inches),	59.50	-	39.43	-

ANNUAL REPORT OF C. A. GOESSMANN,

TREASURER OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION,

For the Year ending Dec. 20, 1892.

RECEIVED.		
Cash on hand from last year,	$3 31	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from State Treasurer, Columbian Exhibition,	150 00	
Cash from fertilizer account,	2,310 00	
Cash from dairy bureau,	628 50	
Cash from farm,	1,014 14	
		$14,131 95
EXPENDED.		
Cash paid salaries,	$3,927 51	
Cash paid laboratory supplies,	579 04	
Cash paid printing and office expenses,	576 45	
Cash paid farmer and farm labor,	2,254 96	
Cash paid farm supplies,	1,749 21	
Cash paid dairy bureau account,	402 06	
Cash paid fertilizer account,	2,304 50	
Cash paid construction and repairs,	774 56	
Cash paid expense of Board of Control,	152 34	
Cash paid incidental expenses,	589 66	
Cash paid library,	358 99	
Cash on hand,	462 67	
		$14,131 95

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION (DEC. 31, 1892).

Farm.		
Live stock,	$628 88	
Tools, implements and machinery,	996 80	
Produce on hand,	832 60	
Fertilizers,	31 60	
Chemical Laboratory:		
Laboratory inventory,	3,005 27	
Office furniture, library, etc.,	1,978 50	
Agricultural and Physiological Laboratory:		
Furniture, herbariums, library (first floor),	734 35	
Instruments, apparatus, etc. (first floor),	761 20	
Furniture (second floor),	409 52	
Instruments, apparatus, etc. (second floor),	412 40	
Buildings, land, etc.,	32,202 00	
Total of inventory,		$41,993 12

This is to certify that I have examined the books and accounts of Charles A. Goessmann, Treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 31, 1892, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of four hundred and sixty-two sixty-seven one hundredths dollars, which is shown to be in the bank.

WM. R. SESSIONS,
Auditor.

JAN. 10, 1893.

LIST OF EXCHANGES.

Reports and Bulletins of the United States Department of Agriculture, Washington, D. C.
Reports and Bulletins of the Agricultural Experiment Stations of the United States.
Bulletin of the State Board of Agriculture, Boston, Mass.
Bulletin of the Massachusetts Horticultural Society, Boston, Mass.
The American Cultivator, Boston, Mass.
The Holstein-Friesian Register, Boston, Mass.
Massachusetts Ploughman, Boston, Mass.
New England Farmer, Boston, Mass.
New England Homestead, Springfield, Mass.
The Home and Mart, East Boston, Mass.
New York Weekly World, New York, N. Y.
German Agricultural Horticultural Journal (German), New York, N. Y.
American Agriculturist, New York, N. Y.
The Rural New Yorker, New York, N. Y.
The Florists' Exchange, New York, N. Y.
Vick's Magazine, Rochester, N. Y.
The American Analyst, New York, N. Y.
The Rural Critic, Garratsville, N. Y.
Naturalist Monthly Bulletin, Philadelphia, Pa.
The Practical Farmer, Philadelphia, Pa.
The Farm Journal, Philadelphia, Pa.
The National Stockman and Farmer, Pittsburg, Pa.
Maryland Farmer, Baltimore, Md.
Baltimore Weekly Sun, Baltimore, Md.
The Agricultural Epitomist, Indianapolis, Ind.
The New Agricultural Era, Indianapolis, Ind.
The Orange Judd Farmer, Chicago, Ill.
The Western Swineherd, Geneseo, Ill.
The Monist, Chicago, Ill.
German Agricultural and Horticultural Journal, Chicago, Ill.
Detroit Free Press (weekly), Detroit, Mich.

Farmers' Home Weekly, Dayton, O.
American Grange Bulletin, Cincinnati, O.
Journal of the Columbus Horticultural Society, Columbus, O.
The Louisiana Planter, New Orleans, La.
The Wisconsin Farmer, Madison, Wis.
The Weekly Journal, Sioux City, Ia.
Western Farmer and Stockman, Sioux City, Ia.
Hospoda (Bohemian journal), Omaha, Neb.
The Industrialist, Manhattan, Kan.
The Home and Farm, Louisville, Ky.
The Industrial American, Lexington, Ky.
Southern Cultivator, Atlanta, Ga.
West American Scientist, Los Angeles, Cal.
California Cultivator and Poultry Keeper, Los Angeles, Cal.
Mirror and Farmer, Manchester, N. H.
Journal of the Elisha Mitchell Scientific Society, Chapel Hill, N. C.
The Journal of Agriculture, Montreal, Can.
Bulletins of the Central Experiment Farm, Ottawa, Can.
Bulletins of Department of Agriculture, New South Wales, Australia.
Bulletins of Department of Agriculture, Brisbane, Queensland.
Relatorio Annual da Estacao Argonomica de Campinas, Sao Paulo, Brazil.
Ragguagli, Laboratorio Chimico Agrario di Bologna, Bologna, Italy.
Reglamento, etc., Estacion Agronomica del Instituto Agricola de Alfonso XII., Madrid, Spain.

INDEX

TO TENTH ANNUAL REPORT, 1892.

PUBLIC DOCUMENT . . . . No. 33.

ELEVENTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1893.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
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BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 Post Office Square.
1894.

Commonwealth of Massachusetts.

Boston, Jan. 10, 1894.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Eleventh Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,

Secretary.

MASSACHUSETTS STATE

AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

BOARD OF CONTROL, 1893.

His Excellency William E. Russell,
Governor of the Commonwealth, President ex officio.

W. H. Bowker of Boston, ... Term expires, 1895.
C. L. Hartshorn of Worcester, ... Term expires, 1894.
Appointed by the State Board of Agriculture.

J. H. Demond of Northampton, ... Term expires, 1896.
E. D. Howe of Marlborough, ... Term expires, 1896.
Appointed by the Board of Trustees of the Massachusetts Agricultural College.

F. H. Appleton of Peabody, ... Term expires, 1894.
Appointed by the Massachusetts Society for Promoting Agriculture.

W. H. Porter of Agawam, ... Term expires, 1894.
Appointed by the Massachusetts State Grange.

Wm. C. Strong of Newton Highlands, . . Term expires, 1894.
Appointed by the Massachusetts Horticultural Society.

H. H. Goodell, A.M., LL.D., Amherst,
President of the Massachusetts Agricultural College.

C. A. Goessmann, Ph.D., LL.D., Amherst,
Director of the Station.

Wm. R. Sessions, Hampden,
Secretary of the State Board of Agriculture.

OFFICERS ELECTED BY THE BOARD.

H. H. Goodell, Amherst,
Vice-President.

Wm. R. Sessions, Hampden,
Secretary and Auditor.

C. A. Goessmann, Amherst,
Treasurer pro tem.

STATION STAFF.

C. A. GOESSMANN, Ph.D., LL.D., *Director and Chemist*, . . Amherst.

J. B. LINDSEY, Ph.D., *Associate Chemist (Feeding Department)*, . Amherst.

ASSISTANTS.

C. S. CROCKER, B.S., .	*General and Analytical Chemistry.*
H. D. HASKINS, B.S., .	" " "
C. H. JONES, B.S., . .	" " "
F. L. ARNOLD, B.S., .	" " "
C. H. JOHNSON, B.S., .	*Assistant Chemist and Feeding Department.*
E. B. HOLLAND, B.S., .	" " " "
R. H. SMITH, B.S., . .	*Assistant Chemist and Field Experiments.*
L. E. GOESSMANN, . .	*Assistant Chemist and Clerk.*
DAVID WENTZELL, . .	*Farmer.*

ELEVENTH ANNUAL REPORT OF THE DIRECTOR

OF THE

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN: — The work carried on at the State Agricultural Experiment Station during the past year compares favorably with that of the preceding year. The various lines of investigation presented for your consideration and indorsement at the different meetings of the Board have been followed up to the full extent of the resources at my disposal. The results obtained in some cases cannot fail to be of more than ordinary interest to the farmers of our State, while in others more time is needed for observation to draw reliable conclusions from the results thus far secured.

The recent additions and improvements in the outfit of the feeding department have aided materially in the investigation of more intricate questions of animal nutrition. The economical production of milk, beef, mutton, veal and pork has received serious attention. New concentrated feed stuffs, as well as coarse fodder articles raised upon the station grounds and new to our section of the country, have been practically tested, to ascertain their relative economical value as compared with current modes of feeding. The digestibility of various concentrated feed stuffs has been carefully tested by Dr. J. B. Lindsey in a series of trials with sheep. Experiments for ascertaining the relative economy of feeding skim-milk to young pigs and calves raised for the meat market have been instituted. A detailed account of these experiments will be found farther on under the following headings: —

PART I.

ON FEEDING EXPERIMENTS.

I. Feeding experiments with milch cows (two).

1. General feeding experiments with milch cows: —
   Grain feed: Buffalo gluten feed, wheat bran and cotton-seed meal.
   Coarse feed: English hay, corn stover, and corn and soja-bean ensilage.
2. Summer feeding experiments with milch cows: —
   Grain feed: Buffalo gluten feed, new-process linseed meal, wheat bran and cotton-seed meal.
   Coarse feed: rowen, green fodder corn and green vetch and oats.
3. Creamery record of the station for 1892 and 1893.

II. Feeding experiments with steers.

III. Feeding experiments with lambs.

IV. Feeding experiments with pigs (two).

V. Feeding experiments with calves.

VI. Digestion experiments with sheep.

VII. Feeding experiments with horses.

The past season was not quite as favorable for the conducting of field experiments as some preceding years have been. A serious drought at the close of the growing period affected the results in a number of cases. Many of the results obtained may, however, be considered satisfactory. The following lines of investigation have been carried on in the field.

PART II.

ON FIELD EXPERIMENTS.

1. Field experiments to ascertain the effect of the exclusion of every form of nitrogen-containing manurial matter from the fertilizer applied for the production of a grain crop (oats) on its yield per acre (Field A).
2. Field experiments with prominent varieties of grasses and grass mixtures under fairly corresponding circumstances and with different varieties on potatoes (Field B).
3. Field experiments regarding the effect of different combinations of commercial fertilizers on the yield of some prominent garden crops (Field C).
4. Observations regarding the adaptation of a variety of more or less reputed fodder plants new to our section of the country (Field D).

5. Field experiments with different commercial phosphates, to study the economy of using the cheaper natural phosphates or the more costly acidulated phosphates (Field F).
6. Field experiments to show the effect of barn-yard manure on the yield of corn (Field G).
7. Field experiments to determine the effect of various fertilizer mixtures on leguminous and grain crops (East Field).
8. Observations on permanent grass lands, — meadows.
9. Report on general farm work.
10. On special fertilization with reference to some prominent industrial crops, fruits and garden vegetables.

The recently increased facilities for chemical analysis have been tested to their full capacity, as may be seen from the following enumeration of examinations called for: —

Fertilizers, official,	214
Fertilizers, sent on,	50
Fertilizers, for station,	24
Fodders, sent on,	32
Fodders, for station,	31
Wood ashes,	108
Milk, for station,	295
Milk, sent on,	26
Cream,	46
Skim-milk,	24
Buttermilk,	8
Water,	93
Miscellaneous,	32

The entire work carried on in the chemical department will be found in subsequent pages under the following heads: —

Part III.

Special Work in the Chemical Laboratory.

I. Communication on commercial fertilizers: —

1. General introduction.
2. State laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1893, to May 1, 1894 (52).
4. Analyses of licensed fertilizers (214).
5. Analyses of commercial fertilizers and manurial substances sent on for examination (169).
6. Miscellaneous analyses (7).
7. Miscellaneous fodder analyses (45).

II. Analyses of milk sent on for examination (26).
III. Analyses of water sent on for examination (93).
IV. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse materials used for fertilizing purposes.
V. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.
VI. Table of the digestibility of American feed stuffs.

The meteorological observations for local purposes have been continued, and the results reported to the authorities in Boston and Washington. The periodical publications of the work accomplished at the station have been continued, seven bulletins having been issued during the year, treating mainly of analyses of fertilizers, feed stuffs, etc. The interest in these publications has manifested itself by a steady increase of applications from within the State as well as other parts of the country.

The general condition of some of the buildings of the experiment station is such that in the interest of good economy serious attention for more extensive repairs seems advisable at this time. As the existing financial resources do not warrant the expenditures in that direction, I recommend the application for suitable appropriation by the State Legislature to meet these wants.

I feel it my pleasant duty to express to you my particular satisfaction for the assistance I have received from all parties engaged with me in the work accomplished during the past year. Thanking you for your kind support in the performance of the duties assigned me, I am,

Yours very respectfully,

C. A. GOESSMANN,

Director of the Massachusetts State Agricultural Experiment Station.

PART I.

FEEDING EXPERIMENTS.

BY J. B. LINDSEY.

I. Feeding Experiments with Milch Cows (two).
II. Feeding Experiments with Steers.
III. Feeding Experiments with Lambs.
IV. Feeding Experiments with Pigs (two).
V. Feeding Experiments with Calves.
VI. Digestion Experiments with Sheep.
VII. Feeding Experiments with Horses.

General Introduction.

The feeding experiments described in this report have been conducted with a view to answering many of the practical questions asked by the farmers of Massachusetts. Several of them are a continuation of those published in previous reports, while others have been started to answer questions of importance to the farming community. They are divided as follows: —

I. *Feeding Experiments with Milch Cows.*

The principal objects of these experiments have been: —

1. To ascertain the comparative value of different kinds of *coarse fodders* upon the economical production of milk and cream.

2. To notice the effects of these foods, if any, upon the composition of the milk and cream.

Many other facts are also brought out in the experiment, as, for example, the number of quarts of milk required to produce a space of cream, etc.

The general object of all the experiments with milch cows has been to find those methods of feeding best suited to produce milk and cream at the minimum cost, and to do this by raising a greater variety of coarse fodder articles upon the farm, and supplementing these fodders with concentrated feed stuffs.

II. *Feeding Experiments with Steers.*

These experiments have been in progress for several years, with these objects in view: —

1. To ascertain those fodder rations that would produce the greatest growth for the least outlay of money.

2. To find out what it actually costs to produce beef in Massachusetts.

3. To compare the relative merits of soiling *vs.* pasture for growing stock during the summer months.

III. Feeding Experiments with Lambs (Winter).

The objects sought have been : —

1. To find the cost of producing live weight under a rational system of feeding.

2. To find out if ensilage could be substituted to a considerable extent for rowen in the coarse fodder rations.

IV. Feeding Experiments with Pigs.

Objects : —

1. To ascertain the value of Buffalo gluten feed and corn meal when fed in connection with skim-milk.

2. The cost of producing pork.

V. Feeding Experiments with Calves.

Objects : —

1. To ascertain whether it is more profitable to feed skim-milk to growing calves or to pigs.

2. To find the rate of growth when calves are fed on skim-milk alone, and when fed on skim-milk and grain.

In all the five experiments thus far mentioned, especial attention is called to the value of the manure produced in connection with a rational system of general farm management. Upon the character of the food fed depends not only the quantity of milk, beef, pork or mutton produced, but also the value of the manure obtained.

VI. Digestion Experiments with Sheep.

The object of these experiments has been to inquire into the digestibility of English mixed hay and of the new con-

centrated feed stuffs, such as Buffalo gluten feed, the new and old process linseed meals, etc.

VII. *Feeding Experiments with Horses.*

This section contains facts in relation to the feeding of four horses at the station during several years past (1888-93).

Farmers are especially requested to address the station if questions arise relating to the experiments herein described, or if any information is desired concerning any problem in stock feeding. Any information at the command of the station will be cheerfully given.

J. B. LINDSEY.

I.

FEEDING EXPERIMENTS WITH MILCH COWS (TWO).

1. General Feeding Experiments with Milch Cows.

October, 1892, to July, 1893.

[Grain feed: Buffalo gluten feed, wheat bran and cotton-seed meal; coarse feed: English hay, corn stover and corn and soja-bean ensilage.]

Objects of the Experiment.

1. To study the comparative feeding effects of English hay, corn stover and corn and soja-bean ensilage upon the cost, quantity and quality of the milk produced.

2. The comparative feeding value of rowen *vs.* hay of peas and oats.

Attention is also called to the value of the manurial ingredients in the feed consumed, and to the value of the manure produced by the different rations fed; also the quality of the milk produced during the different feeding periods.

History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).	Number of Months on Trial.
May, . .	Native, ...	6 7	Jan. 15, 1892,	6–7	9
Gem, . .	Grade Shorthorn, .	5	Dec. 6, 1891,	11–12	10
Lucy, . .	Grade Ayrshire, .	6	June 2, 1891,	8–9	17
Florence, .	Grade Shorthorn, .	7	May 13, 1892,	10–11	5
Viola, . .	Native, ...	(?)	Feb. 10, 1892,	5–6	7
Anna, . .	Native, ...	(?)	Jan. 26, 1892,	5–6	8
Stella, . .	Grade Durham, .	11	Jan. 5, 1893,	16–17	–
Jennie, .	Grade Jersey, . .	4	Dec. 25, 1892,	10–11	–
Julia, . .	Native, ...	9	Jan. 18, 1893,	12–13	–
Nora, . .	Grade Ayrshire, .	5	Mar. 25, 1893,	–	–

As will be seen from the above record, these cows are grades of various descriptions and of different milking periods. They probably represent average cows of the various herds kept by farmers in this section of the State.

It will be observed that only two of the cows, viz., Gem and Florence, were retained during the entire experiment, several having been dropped, owing to a too advanced stage of milking, and new milch cows put in their places. The records of all the cows on trial are, however, presented, as they furnish data from which to judge of the comparative feeding effects of the several varieties of fodder.

Description of Fodder Articles.

The grain feed remained constant throughout the entire experiment, and consisted of Buffalo gluten feed, wheat bran and cotton-seed meal. The chemical and mechanical condition was good.

The coarse feed consisted of good hay of mixed grasses, rowen (second cut of grass lands), well-cured hay of peas and oats, corn stover, corn and soja-bean ensilage and globe mangolds.

The ensilage was made from "Pride of the North" corn and a late variety of soja bean, cut up into pieces several inches in length. The corn was cut for ensilage when the kernels had begun to glaze. The soja bean was a late variety which failed to blossom. When cut it measured three and one-half feet in height.

Silo No. 1 contained equal weight parts of corn and soja bean, while silo No. 2 contained two parts of soja bean to one part of corn. These ensilages are called respectively corn and soja-bean ensilage and soja-bean and corn ensilage. The silos were filled rapidly, and treated as described in previous reports. Silo No. 1 was much larger, and contained several times as much ensilage as No. 2.

The corn stover was obtained from the same variety of corn as that put into the silo, and is the field-cured plant remaining after the fully matured ears have been removed. It was cut into short lengths before being fed. The hay of peas and oats was the portion that remained over from the summer green feeding, and was cut when in late blossom and dried.

The following tables contain the analyses of the various grains and coarse fodders, together with their fertilizing value obtainable after they have passed through the animal, *i. e.*, in the manure.

Analyses of Fine Feed used.

Fodder Analyses.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.
Moisture at 100° C.,	10.35	8.28	7.00
Dry matter,	89.65	91.72	93.00
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	7.39	0.91	7.45
" cellulose,	11.60	7.78	6.63
" fat,	5.72	13.61	12.20
" protein,	17.78	26.03	44.33
Non-nitrogenous extract matter,	57.51	51.67	29.39
	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.
Moisture,	10.35	8.28	7.00
Nitrogen,	2.45	3.82	6.59
Phosphoric acid,	2.85	0.46	2.33
Potassium oxide,	1.63	0.10	1.72
Valuation per 2,000 pounds,	$11 95	$12 06	$23 88
Manurial value obtainable,	9 56	9 65	19 10

Analyses of Course Fodder Articles used.

FODDER ANALYSES.	Hay.	Rowen.	Hay of Peas and Oats.	Corn Stover.	Corn and Soja-bean Ensilage.*	Soja-bean and Corn Ensilage.†	Globe Mangolds.
Moisture at 100° C., . .	9.00	11.31	12.30	14.66	77 77	80.33	88.51
Dry matter, ...	91.00	88.69	87.70	85.34	22.23	19.67	11.49
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash, ...	6.64	6.48	6.90	5.49	9.48	11.91	12 88
" cellulose, ...	34.82	29.98	26.66	37.57	26.63	29.00	9.98
" fat, ...	3.18	4.23	2.29	1.82	3.75	3.02	1.14
" protein, ...	10.41	12.11	16.01	4.00	7.91	8.41	7.04
Non-nitrogenous extract matter, ...	44 95	47.20	48.14	51.12	52 23	47.66	68.96
	100.00	100.00	100.00	100.00	100.00	100 00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

FERTILIZER ANALYSES.	Hay.	Rowen.	Hay of Peas and Oats.	Corn Stover.	Corn and Soja-bean Ensilage.*	Soja-bean and Corn Ensilage.†	Globe Mangolds.
Moisture, ...	9.00	11 30	12.30	14.66	77.77	80.33	88.51
Nitrogen, ...	1.52	1.72	2.24	0.55	0.32	0.27	0.13
Phosphoric acid, . . .	0.35	0.46	0.65	0.23	0.12	0.12	0.10
Potassium oxide, . . .	1.54	1.97	2.10	1.84	0.48	0.48	0.47
Valuation per 2,000 pounds,	$6 32	$6 56	$9 32	$3 55	$1 52	$1 37	$0 92
Manurial value obtainable, .	5 06	5 25	7 46	2 84	1 22	1 10	0 74

* Equal parts by weight. † Two parts soja bean to one part corn.

Mode of Feeding.

The entire experiment is divided into two parts: Part 1 includes hay, hay and roots, corn stover, "corn and soja-bean ensilage," and "soja-bean and corn ensilage." It covers nearly eight months. The feeding periods vary in length from several weeks to several months in case of the corn and soja-bean ensilage. Part 2 has only two feeding periods, and extends over but one month of time.

The grain ration remained constant during the entire experiment, and consisted of three pounds each of wheat bran, Buffalo gluten feed and cotton-seed meal. One-half the grain was fed at the time of milking in the morning, together with one-half of the coarse fodder; and the other half, together with the remainder of the coarse fodder, at the time of milking in the afternoon, about five o'clock.

The animals were watered twice each day, about two hours after feeding.

The amount of coarse fodder fed depended upon the individual appetite of the different animals. Hay constituted the entire coarse feed in the first feeding period, and amounted to fifteen pounds per day. In the second period fifteen pounds of globe mangolds were added. The corn stover consumed in the third period amounted to from twelve to fourteen pounds daily. When first fed the animals consumed somewhat more, but the amount gradually decreased to twelve to fourteen pounds, which can be regarded as the average daily consumption. During the fourth and fifth periods the hay feed was limited to four pounds daily, while the ensilage was fed *ad libitum*. This generally amounted to from forty to sixty pounds per day, with fifty pounds as a fair average. During the sixth period the hay of peas and oats consumed varied from fourteen to sixteen pounds daily, and the rowen in the seventh period, from sixteen to eighteen pounds per day.

For more details see the record of each cow.

Local Market Cost, per Ton, of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	20 00
Cotton-seed meal,	28 00
Hay,	15 00
Rowen,	15 00
Hay of peas and oats,	15 00
Corn stover,	5 00
Corn and soja-bean ensilage,	2 75
Soja-bean and corn ensilage,	2 75
Globe mangolds,	4 00

The commercial value of the various fodder rations about to be described is based upon the above-stated market cost.

Average Composition of the Daily Fodder Rations used during the Seven Successive Feeding Periods (1892–1893).

3 pounds wheat bran equal 4 quarts.
3 pounds Buffalo gluten feed equal 3 quarts.
3 pounds cotton-seed meal equal 2 quarts.

I.	
October 18 to November 9.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Hay,	15 "
Nutritive ratio,	1 : 4.5
Total cost,	21.3 cts.
Manurial value obtainable,	9.54 "
Net cost,	11.76 "

II.	
November 14 to December 3.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Hay,	15 "
Globe mangolds,	15 "
Nutritive ratio,	1 : 4.9
Total cost,	24.3 cts.
Manurial value obtainable,	10.10 "
Net cost,	14.20 "

III.	
December 12 to January 9.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Corn stover,	15 "
Nutritive ratio,	1 : 4.8
Total cost,	13.85 cts.
Manurial value obtainable,	7.88 "
Net cost,	5.97 "

IV.	
January 18 to April 4.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Hay,	4 "
Corn and soja-bean ensilage,	50 "
Nutritive ratio,	1 : 4.9
Total cost,	19.90 cts.
Manurial value obtainable,	9.81 "
Net cost,	10.09 "

V.	
May 11 to May 26.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Hay,	4 "
Soja-bean and corn ensilage,	50 "
Nutritive ratio,	1 : 4.8
Total cost,	19.90 cts.
Manurial value obtainable,	9.51 "
Net cost,	10.39 "

VI.	
June 8 to June 21.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Hay of peas and oats,	16 "
Nutritive ratio,	1 : 3.77
Total cost,	22.05 cts.
Manurial value obtainable,	10.36 "
Net cost,	11.69 "

Average Composition of the Daily Fodder Rations — Concluded.

VII.

June 27 to July 6.

Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Cotton-seed meal,	3 "
Rowen,	18 "
Nutritive ratio,	1 : 4.51.
Total cost,	23.55 cts.
Manurial value obtainable,	10.48 "
Net cost,	13.07 "

Summary of Cost of the Average Daily Fodder Rations.

[Cents.]

	Total Cost.	Manurial Value Obtainable.	Net Cost.
I. Grain and hay,	21.30	9.54	11.76
II. Grain, hay and mangolds,	24.30	10.10	14.20
III. Grain and corn stover,	13.85	7.88	5.97
IV. Grain, hay and ensilage,	19.90	9.81	10.09
V. Grain, hay and ensilage,	19.90	9.51	10.39
VI. Grain and hay of peas and oats,	22.05	10.36	11.69
VII. Grain and rowen,	23.55	10.48	13.07

The *total cost* of a fodder ration is the sum of the market costs of the different articles consumed per day. The *manurial value obtainable* is the value of the nitrogen, phosphoric acid and potash of the ration fed that will be found in the manure. In case of milch cows this amounts on an average to 80 per cent. of the fertilizing ingredients contained in the feed. The other 20 per cent. goes into the milk or flesh of the animal. The value of the nitrogen, phosphoric acid and potash thus excreted is based upon the retail

cost of these articles in the open markets. When the experiment was in operation this amounted to 15 cents per pound for nitrogen, $5\frac{1}{2}$ cents per pound for phosphoric acid and $4\frac{1}{2}$ cents per pound for potash. The *net cost* of a ration is that cost remaining after the value of the manure has been deducted from the total cost. It is to be observed that the value of the manure, *i.e.*, its content of nitrogen, phosphoric acid and potash, depends entirely upon the character of the fodder articles fed. Thus, if the feed consists of corn meal and hay, each of which articles have an obtainable manurial value of about $5 per ton, the value of the manure will be considerably inferior to one where cotton-seed meal with an obtainable manurial value of about $20 per ton or wheat bran with an obtainable manurial value of $10 per ton are fed.

All the concentrated feed stuffs, such as linseed meal, cotton-seed meal, gluten meal, gluten feed and wheat bran, have a very high percentage of nitrogen, which greatly increases the value of the manure produced by the animal.

Quantity and Cost of Milk produced per Day.

FEEDING PERIODS.	MAY.		GEM.		LUCY.		VIOLA.		ANNA.	
	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
Part 1.										
I. Grain and hay, . . .	6.34	3.36	11.24	1.89	8.45	2.52	5.82	3.65	5.80	3.67
II. Grain, hay and mangolds,	6.47	3.76	11.93	2.04	8.84	2.75	5.23	4.61	5.72	*3.60
III. Grain and corn stover, .	4.94	2.71	9.26	1.45	6.69	1.95	3.74	3.78	4.75	2.73
IV. Grain, hay and ensilage, .	-	-	12.21	1.55	7.30	2.27	-	-	-	-
V. Grain, hay and ensilage, .	-	-	11.77	1.71	-	-	-	-	-	-
Part 2.										
VI. Grain and peas and oats,	-	-	10.32	2.04	-	-	-	-	-	-
VII. Grain and rowen, . .	-	-	11.03	2.07	-	-	-	-	-	-
Average, . . .	5.92	3.28	11.11	1.82	7.82	2.37	4.98	4.01	5.42	3.33

* Cow consumed five pounds less hay per day during this period.

Quantity and Cost of Milk produced per Day — Continued.

FEEDING PERIODS.	Florence.		Julia.		Jennie.		Nora.	
	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.	Quantity Daily.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
Part 1.								
I. Grain and hay, ...	10.46	2.04	-	-	-	-	-	-
II. Grain, hay and mangolds, .	10.58	2.29	-	-	-	-	-	-
III. Grain and corn stover, .	7.12	1.87	-	-	-	-	-	-
IV. Grain, hay and ensilage, .	9.31	2.14	12.85	1.52	10.86	1.72	-	-
V. Grain, hay and ensilage, .	8.24	2.43	11.50	1.73	9.50	2.02	11.45	1.73
Part 2.								
VI. Grain and peas and oats, .	7.20	3.00	-	-	8.70	2.42	10.48	1.94
VII. Grain and rowen, . .	7.52	3.13	9.30	2.37	8.19	2.58	10.60	2 08
Average, ...	8.63	2.41	11.22	1.87	9.31	2.18	10.84	1.92

Comments on the Above Results.

Remembering that during the entire experiment the grain ration remained the same, and that the quantity of coarse fodders fed was in all cases governed by the individual appetite of the animal, the following points are worthy of notice : —

1. That when the roots were added to the hay ration the flow of milk in four cases out of six increased, in one case remained constant and in one case slightly decreased. The increased yield, however, was not sufficient to pay for the extra cost of the roots, and the total cost of the milk per quart was noticeably increased in this period.

2. The grain and hay ration produced a comparatively fair yield, but the average cost of production per quart in the case of three cows whose record extends through the three periods was above that for the corn stover and corn and soja-bean ensilage rations. The cost per quart when hay was fed as the coarse fodder was 2.15 cents, with corn stover but 1.76 cents and with ensilage 1.99 cents.

3. The yield of milk decreased on an average 25 per cent. during the corn-stover period; but because of the low

market value of this fodder the average cost of producing one quart of milk, in case of three cows, was lowest in this period, namely, 1.76 cents.

4. In feeding period IV. (corn and soja-bean ensilage), where cows Gem, Lucy and Florence are considered, it will be observed that the ensilage caused a marked increase in the yield of milk from Gem, and not a very great decrease in the case of the other two cows. These results, together with the fact that the period lasted seventy-five days, during which time the cows would naturally shrink some in their yield, indicates that the corn and soja-bean ensilage was instrumental in stimulating the flow of milk. This period produced milk, in case of five cows whose average yield was 10.5 quarts per day, at 1.84 cents per quart, which may be considered fairly low.

5. In comparing the merits of rowen and the hay of peas and oats, it will be observed that there is no great difference in the results. The yield of milk was slightly increased by the rowen over the peas and oats, but rather more rowen was consumed, making the cost per quart of milk a trifle higher. It can be stated, however, that hay of well-cured peas and oats compares very favorably with a good quality of rowen for milk production.

6. That the cost of milk per quart depends upon the absolute yield is also worthy of notice. It is noticeable that when the cows yield but 4 to 5 quarts of milk per day the total cost of this milk is 3½ to 4 cents per quart; and when 6 quarts are produced the cost is about 3 cents per quart. This fact has been previously emphasized in the reports of the station, namely, that a cow ceases to be profitable when she yields but 6 quarts or less per day. If the farmer, therefore, would make milk production profitable it is of the utmost importance that he should select cows that are capable of giving large and continuous yields of milk. A herd of cows in which the average yield is but 7 to 8 quarts cannot be a very profitable one.

Quality of Milk produced.

Feeding Periods.	Rations.	May. Total Solids.	May. Fat.	Gem. Total Solids.	Gem. Fat.	Lucy. Total Solids.	Lucy. Fat.	Viola. Total Solids.	Viola. Fat.	Anna. Total Solids.	Anna. Fat.	Florence. Total Solids.	Florence. Fat.	Jennie. Total Solids.	Jennie. Fat.	Julia. Total Solids.	Julia. Fat.	Nora. Total Solids.	Nora. Fat.
	Part 1.																		
I. 22 days.	Grain and hay,	14.00	3.50	13.76	3.90	14.57	4.05	13.89	3.90	11.76	2.70	14.24	4.65	-	-	-	-	-	-
	Grain and hay,	13.72	3.60	13.50	4.05	13.27	4.20	14.80	3.80	12.03	2.60	14.22	4.25	-	-	-	-	-	-
	Average,	**13.86**	**3.55**	**13.63**	**3.97**	**13.92**	**4.12**	**14.34**	**3.85**	**11.90**	**2.65**	**14.23**	**4.45**	-	-	-	-	-	-
II. 19 days.	Grain, hay and mangolds,	13.16	3.40	13.82	4.40	13.33	4.60	13.68	4.20	12.22	2.80	13.72	4.40	-	-	-	-	-	-
	Grain, hay and mangolds,	13.27	3.40	13.03	4.60	14.37	4.60	14.08	4.20	11.23	2.80	14.14	4.40	-	-	-	-	-	-
	Average,	**13.21**	**3.40**	**13.41**	**4.50**	**13.85**	**4.60**	**13.88**	**4.20**	**11.72**	**2.80**	**13.93**	**4.40**	-	-	-	-	-	-
III. 28 days.	Grain and corn stover,	14.02	4.80	13.47	4.00	14.27	5.00	14.38	4.20	11.73	3.00	14.13	5.00	-	-	-	-	-	-
	Grain and corn stover,	-	-	14.06	4.00	14.55	5.40	-	-	-	-	14.37	5.10	14.13	4.40	-	-	-	-
	Average,	**14.02**	**4.80**	**13.76**	**4.00**	**14.41**	**5.20**	**14.38**	**4.20**	**11.73**	**3.00**	**14.25**	**5.05**	**14.13**	**4.40**	-	-	-	-
IV. 86 days.	Grain, hay, and corn and soja-bean ensilage,	-	-	12.42	3.66	-	-	-	-	-	-	13.97	4.36	-	-	-	-	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	13.14	4.22	-	-	-	-	-	-	13.31	4.42	-	-	-	-	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	13.48	4.26	-	-	-	-	-	-	13.84	-	-	-	-	-	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	12.96	4.30	-	-	-	-	-	-	13.81	4.62	-	-	-	-	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	12.93	4.30	-	-	-	-	-	-	13.08	4.67	-	-	-	-	-	-
	Grain, hay, and corn and soja bean ensilage,	-	-	14.36	5.13	14.14	4.88	-	-	-	-	13.36	4.18	14.42	3.93	14.02	5.38	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	13.09	4.06	14.05	4.90	-	-	-	-	13.83	4.22	14.35	5.20	14.58	5.26	-	-

Quality of Milk produced — Concluded.

Feeding Periods.	Rations.	May. Total Solids.	May. Fat.	Gem. Total Solids.	Gem. Fat.	Lucy. Total Solids.	Lucy. Fat.	Viola. Total Solids.	Viola. Fat.	Anna. Total Solids.	Anna. Fat.	Florence. Total Solids.	Florence. Fat.	Jennie. Total Solids.	Jennie. Fat.	Julia. Total Solids.	Julia. Fat.	Nora. Total Solids.	Nora. Fat.
IV. 86 days.	Grain, hay, and corn and soja-bean ensilage,	-	-	13.33	4.19	14.03	4.89	-	-	-	-	14.24	4.68	14.22	5.18	14.48	5.27	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	13.72	4.76	14.25	4.88	-	-	-	-	14.14	4.82	14.43	5.27	14.04	4.86	-	-
	Grain, hay, and corn and soja bean ensilage,	-	-	13.13	3.99	-	-	-	-	-	-	14.09	4.80	14.29	5.05	13.84	4.71	-	-
	Grain, hay, and corn and soja-bean ensilage,	-	-	12.91	4.33	-	-	-	-	-	-	14.24	4.86	-	-	14.59	5.29	-	-
	Average,	-	-	**13.22**	**4.72**	**14.12**	**4.89**	-	-	-	-	**13.99**	**4.56**	**14.34**	**4.92**	**14.26**	**5.13**	-	-
V. 25 days.	Grain, hay, and soja-bean and corn ensilage,	-	-	13.59	4.08	-	-	-	-	-	-	13.82	4.52	14.63	5.33	13.85	4.75	13.49	3.99
	Grain, hay, and soja-bean and corn ensilage,	-	-	13.13	4.05	-	-	-	-	-	-	-	-	14.68	5.41	13.76	4.70	13.86	4.23
	Grain, hay, and soja-bean and corn ensilage,	-	-	13.38	4.31	-	-	-	-	-	-	13.50	4.34	14.20	5.39	13.84	4.69	13.59	3.86
	Grain, hay, and soja-bean and corn ensilage,	-	-	13.17	3.77	-	-	-	-	-	-	13.50	4.21	14.38	5.09	13.32	4.75	13.97	4.34
	Average,	-	-	**13.19**	**4.05**	-	-	-	-	-	-	**13.61**	**4.36**	**14.47**	**5.21**	**13.69**	**4.72**	**13.73**	**4.11**
	Part 2.																		
VI. 14 days.	Grain and hay of peas and oats,	-	-	13.29	4.10	-	-	-	-	-	-	13.81	4.20	14.64	5.11	-	-	13.50	4.41
	Grain and hay of peas and oats,	-	-	13.61	3.91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Average,	-	-	**13.45**	**4.10**	-	-	-	-	-	-	**13.81**	**4.20**	**14.64**	**5.11**	-	-	**13.50**	**4.41**
VII. 9 days.	Grain and rowen,	-	-	12.87	3.91	-	-	-	-	-	-	13.91	4.54	14.85	5.27	13.83	4.67	12.83	3.44
	Grain and rowen,	-	-	13.09	4.09	-	-	-	-	-	-	13.85	4.51	13.96	4.25	13.78	4.39	12.86	4.18
	Average,	-	-	**12.98**	**4.00**	-	-	-	-	-	-	**13.88**	**4.52**	**14.41**	**4.76**	**13.81**	**4.53**	**12.85**	**3.81**

At the beginning of the experiment, samples of the milk were taken daily, but it was finally decided to make a composite sample of three days' milk (Monday, Tuesday and Wednesday) of each week, believing that in this way a better knowledge of the composition of the milk produced by the various cows could be obtained.

Did the Coarse Fodders Influence the Quality of the Milk?

By the quality of the milk the percentages of total solids and of fat are referred to. A close study of the analyses of the milk in the various periods leads to the conclusion that the different coarse fodders exerted no decided influence upon the composition of the milk. There were variations from week to week, both in the percentage of total solids and of fat, but no marked change is noticed in any one particular period, and the slight variations that do occur should without doubt be attributed to the condition of the animal, and the consequent influence upon the secretion, rather than to any particular influence due to the feed consumed.

General Conclusions.

This experiment confirms others made at the station, and points out the economy of raising and feeding a greater variety of coarse fodder articles, substituting them for the high-priced hay.

Corn and soja-bean ensilage has proved itself to be fully equal if not superior to hay in producing a yield of milk, without affecting the quality and at the same time decreasing the absolute cost. This ration produced milk at less than two cents per quart.

Roots, while they are beneficial to the health of the animals, especially those fed upon dry fodder, cannot be fed to any extent economically, because of the increased cost of the milk produced.

Hay of peas and oats proved itself to be nearly or quite equal to a good quality of rowen for milk production.

The different coarse fodders have not influenced the composition of the milk to any noticeable extent.

FEEDING RECORD.

May.

Feeding Periods	Feed consumed (Pounds) per Day. Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Corn Stover.	Mangolds.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
1892-93.											
Oct. 18 to Nov. 9,	3.00	3.00	3.00	15.00	–	–	21.88	6.34	3.45	1:4.5	982
Nov. 14 to Dec. 3,	3.00	3.00	3.00	15.00	–	15.00	23.60	6.47	3.65	1:4.9	992
Dec. 12 to Jan. 9,	3.00	3.00	3.00	–	13.43	–	19.69	4.93	3.99	1:4.6	1,023

Viola.

Feeding Periods	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Corn Stover.	Mangolds.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Oct. 18 to Nov. 9,	3.00	3.00	3.00	15.00	–	–	21.88	5.83	3.75	1:4.5	965
Nov. 14 to Dec. 3,	3.00	3.00	3.00	14.73	–	15.00	23.35	5.23	4.46	1:4.9	994
Dec. 12 to Jan. 4,	3.00	3.00	3.00	–	16.61	–	22.40	3.74	5.99	1:4.9	983

Anna.

Feeding Periods	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Corn Stover.	Mangolds.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Oct. 18 to Nov. 9,	3.00	3.00	3.00	15.00	–	–	21.88	5.80	3.77	1:4.5	1,010
Nov. 14 to Dec. 3,	3.00	3.00	3.00	10.21	–	15.00	19.24	5.70	3.38	1:4.4	1,040
Dec. 12 to Jan. 4,	3.00	3.00	3.00	–	11.78	–	18.28	4.75	3.85	1:4.55	1,027

FEEDING RECORD — *Continued.*

Gem.

Feeding Periods.	Feed consumed (Pounds) per Day.										Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Rowen.	Corn Stover.	Hay of Peas and Oats.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Mangolds.					
1892-93.															
Oct. 18 to Nov. 9,	3.00	3.00	3.00	15.00	–	–	–	–	–	–	21.88	11.11	1.97	1:4.5	936
Nov. 14 to Dec. 3,	3.00	3.00	3.00	15.00	–	–	–	–	–	15.00	23.60	11.93	1.98	1:4.9	961
Dec. 12 to Jan. 10,	3.00	3.00	3.00	–	–	13.34	–	–	–	–	19.61	9.26	2.12	1:4.6	929
Jan. 18 to April 4,	2.94	2.94	2.94	4.00	–	–	–	43.22	–	–	22.31	12.21	1.83	1:4.8	941
May 1 to May 26,	2.88	2.88	2.88	4.00	–	–	–	–	51.72	–	21.72	11.76	1.85	1:4.9	967
June 8 to June 22,	3.00	3.00	3.00	–	–	–	14.71	–	–	–	21.13	10.32	2.05	1:3.6	1,012
June 27 to July 6,	3.00	3.00	3.00	–	17.11	–	–	–	–	–	23.40	11.03	2.12	1:4.45	1,002

Lucy.

Feeding Periods.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Rowen.	Corn Stover.	Hay of Peas and Oats.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Mangolds.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Oct. 18 to Nov. 9,	3.00	3.00	3.00	15.00	–	–	–	–	–	–	21.88	8.45	2.59	1:4.5	877•
Nov. 14 to Dec. 3,	3.00	3.00	3.00	15.00	–	–	–	–	–	15.00	23.60	8.84	2.67	1:4.9	888
Dec. 12 to Jan. 10,	3.00	3.00	3.00	–	–	12.31	–	–	–	–	18.74	6.69	2.80	1:4.5	869
Feb. 18 to Mar. 15,	3.00	3.00	3.00	4.00	–	–	–	25.84	–	–	17.61	7.30	2.41	1:4.0	865

FEEDING RECORD — *Continued.*

Florence.

Feeding Periods.	Feed consumed (Pounds) per Day.										Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Rowen.	Corn Stover.	Hay of Peas and Oats.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Mangolds.					
1892-93.															
Oct. 18 to Nov. 9,	3.00	3.00	3.00	15.00	–	–	–	–	–	–	21.88	10.46	2.09	1:4.5	944
Nov. 14 to Dec. 3,	3.00	3.00	3.00	15.00	–	–	–	–	–	15.00	23.60	10.58	2.23	1:4.9	974
Dec. 12 to Jan. 10,	3.00	3.00	3.00	–	–	13.17	–	–	–	–	19.47	7.12	2.73	1:4.6	962
Jan. 18 to April 4,	3.00	3.00	3.00	4.00	–	–	–	49.86	–	–	22.95	9.31	2.47	1:4.9	1,010
May 1 to May 26,	3.00	3.00	3.00	4.00	–	–	–	–	51.18	–	21.93	8.28	2.65	1:5.0	1,004
June 8 to June 22,	3.00	3.00	3.00	–	–	–	15.43	–	–	–	21.76	7.19	3.03	1:3.6	1,088
June 27 to July 6,	3.00	3.00	3.00	–	18.00	–	–	–	–	–	24.19	7.52	3.22	1:4.5	1,064

FEEDING RECORD — *Concluded.*

Nora.

FEEDING PERIODS.	Feed consumed (Pounds) per Day. Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	Hay.	Rowen.	Hay of Peas and Oats.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
1892-93.													
May 1 to May 26, .	3.00	3.00	3.00	4.00	-	-	-	49.14	21.53	11.45	1.88	1:5.00	730
June 8 to June 22, .	3.00	3.00	3.00	-	-	13.71	-	-	19.65	10.48	1.88	1:3.50	744
June 27 to July 6, .	3.00	3.00	3.00	-	16.00	-	-	-	22.42	10.59	2.12	1:4.40	743
Jennie.													
Feb 12 to April 4, .	3.00	3.00	3.00	4.00	-	-	40.45	-	20.86	10.80	1.93	1:4.80	706
May 1 to May 26, .	3.00	3.00	3.00	4.00	-	-	-	45.16	20.75	9.48	2.19	1:4.90	728
June 8 to June 22, .	3.00	3.00	3.00	-	-	14.71	-	-	21.13	8.66	2.44	1:3.55	759
June 27 to July 6, .	3.00	3.00	3.00	-	16.00	-	-	-	22.42	8.19	2.74	1:4.40	740
Julia.													
Feb. 20 to April 4, .	3.00	3.00	3.00	4.00	-	-	47.44	-	22.42	12.88	1.74	1:4.90	824
May 1 to May 26, .	3.00	3.00	3.00	4.00	-	-	-	50.22	21.75	11.51	1.89	1:5.00	801
June 27 to July 6, .	3.00	3.00	3.00	-	16.00	-	-	-	22.42	9.30	2.41	1:4.40	790

Total Cost of Feed per Quart of Milk.

Feeding Periods.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Corn Stover consumed (Pounds).	Globe Mangolds consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
May.										
1892-93.										
Oct. 18 to Nov. 9,	139.48	6.34	66.00	66.00	66.00	330.00	–	–	$4 69	3.36
Nov. 14 to Dec. 3,	122.93	6.47	57.00	57.00	57.00	285.00	–	285.00	4 62	3.75
Dec. 12 to Jan. 9,	138.04	4.93	84.00	84.00	84.00	–	376.00	–	3 75	2.72
Viola.										
Oct. 18 to Nov. 9,	128.14	5.83	66.00	66.00	66.00	330.00	–	–	$4 69	3.65
Nov. 14 to Dec 3,	99.41	5.23	57.00	57.00	57.00	281.00	–	285.00	4 58	4.61
Dec. 12 to Jan. 4,	86.12	3.74	69.00	69.00	69.00	–	382.00	–	3 26	3.78
Anna.										
Oct. 18 to Nov. 9,	127.07	5.80	66.00	66.00	66.00	330.00	–	–	$4 69	3.69
Nov. 14 to Dec. 3,	108.30	5.70	57.00	57.00	57.00	194.00	–	285.00	3 93	3.60
Dec. 12 to Jan. 4,	109.25	4.75	69.00	69.00	69.00	–	271.00	–	2 97	2.72

Total Cost of Feed per Quart of Milk — *Continued.*

Gem.

Feeding Periods.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Hay of Peas and Oats consumed (Pounds).	Corn and Soja-bean Ensilage consumed (Pounds).	Soja-bean and Corn Ensilage consumed (Pounds).	Globe Mangolds consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
1892-93.														
Oct. 18 to Nov. 9, .	244.51	11.11	66.00	66.00	66.00	330.00	–	–	–	–	–	–	$4 69	1.88
Nov. 14 to Dec. 3, .	226.67	11.93	57.00	57.00	57.00	285.00	–	–	–	–	–	285.00	4 62	2.04
Dec. 12 to Jan 10, .	268.54	9.26	87.00	87.00	87.00	–	–	387.00	–	–	–	–	3 87	1.44
Jan. 18 to April 4, .	927.96	12.21	223.50	223.50	223.50	304.00	–	–	–	3,285.00	–	–	14 53	1.56
May 1 to May 26, .	294.00	11.76	72.00	72.00	72.00	100.00	–	–	–	–	1,293.00	–	4 97	1.69
June 8 to June 22, .	144.48	10.32	42.00	42.00	42.00	–	–	–	206.00	–	–	–	2 95	2.04
June 27 to July 6, .	99.27	11.03	27.00	27.00	27.00	–	154.00	–	–	–	–	–	2 05	2.04

Lucy.

Feeding Periods.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Hay of Peas and Oats consumed (Pounds).	Corn and Soja-bean Ensilage consumed (Pounds).	Soja-bean and Corn Ensilage consumed (Pounds).	Globe Mangolds consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Oct. 18 to Nov. 9, .	185.90	8.45	66.00	66.00	66.00	330.00	–	–	–	–	–	–	$4 69	2.52
Nov. 14 to Dec. 3, .	167.96	8.84	57.00	57.00	57.00	285.00	–	–	–	–	–	285.00	4 62	2.75
Dec. 12 to Jan. 10, .	193.02	6.65	87.00	87.00	87.00	–	–	357.00	–	–	–	–	3 80	1.97
Feb. 18 to Mar. 15, .	182.50	7.30	75.00	75.00	75.00	100.00	–	–	–	646.00	–	–	4 16	2.28

TOTAL COST OF FEED PER QUART OF MILK — *Continued.*

Florence.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Hay of Peas and Oats consumed (Pounds).	Corn and Soja-bean Ensilage consumed (Pounds).	Soja-bean and Corn Ensilage consumed (Pounds).	Globe Mangolds consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Oct. 18 to Nov. 9, .	230.12	10.46	66.00	66.00	66.00	330.00	–	–	–	–	–	–	$4 68	2.03
Nov. 14 to Dec. 3, .	201.02	10.58	57.00	57.00	57.00	285.00	–	–	–	–	–	285.00	4 62	2.29
Dec. 12 to Jan 10, .	206.48	7.12	87.00	87.00	87.00	–	–	382.00	–	–	–	–	3 87	1.87
Jan. 18 to April 4, .	707.56	9.31	228.00	228.00	228.00	304.00	–	–	–	3,789.00	–	–	15 11	2.13
May 1 to May 26, .	207.00	8.28	75.00	75.00	75.00	100.00	–	–	–	–	1,279.00	–	5 05	2.44
June 8 to June 22, .	100.66	7.19	42.00	42.00	42.00	–	–	–	216.00	–	–	–	3 03	3.02
June 27 to July 6, .	67.67	7.52	27.00	27.00	27.00	–	172.00	–	–	–	–	–	2 14	3.16

TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

Nora.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Rowen consumed (Pounds).	Hay of Peas and Oats consumed (Pounds).	Corn and Soja-bean Ensilage consumed (Pounds).	Soja-bean and Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
1893.												
May 1 to May 26, . .	286.25	11.45	75.00	75.00	75.00	100.00	–	–	–	1,229.00	$4 88	1.74
June 8 to June 22, . .	146.72	10.48	42.00	42.00	42.00	–	–	192.00	–	–	2 85	1.94
June 27 to July 6, . .	95.31	10.59	27.00	27.00	27.00	–	144.00	–	–	–	1 98	2.07

Jennie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Rowen consumed (Pounds).	Hay of Peas and Oats consumed (Pounds).	Corn and Soja-bean Ensilage consumed (Pounds).	Soja-bean and Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Feb. 12 to April 4, . .	248.40	10.80	69.00	69.00	69.00	92.00	–	–	930.00	–	$4 29	1.73
May 1 to May 26, . .	237.00	9.48	75.00	75.00	75.00	100.00	–	–	–	1,129.00	4 84	2.04
June 8 to June 22, . .	121.26	8.66	42.00	42.00	42.00	–	–	206.00	–	–	2 95	2.42
June 27 to July 6, . .	73.79	8.16	27.00	27.00	27.00	–	144.00	–	–	–	1 98	2.71

Julia.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Hay consumed (Pounds).	Rowen consumed (Pounds).	Hay of Peas and Oats consumed (Pounds).	Corn and Soja-bean Ensilage consumed (Pounds).	Soja-bean and Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Feb. 20 to April 4, . .	180.32	12.88	42.00	42.00	42.00	56.00	–	–	664.00	–	$2 80	1.55
May 1 to May 26, . .	287.75	11.51	75.00	75.00	75.00	100.00	–	–	–	1,256.00	5 01	1.74
June 27 to July 6, . .	83.70	9.30	27.00	27.00	27.00	–	144.00	–	–	–	1 98	2.37

2. Summer Feeding Experiments with Milch Cows.

July, 1892, to September, 1892.

[Coarse fodder articles: rowen, green vetch and oats and green corn fodder; grain feed: wheat bran, Buffalo gluten feed, cotton-seed meal and new process linseed meal.]

Object of the Experiment.

This experiment had for its object the studying of the comparative value of three distinct fodder rations on the economical production of milk and cream during the summer season.

The first ration consisted of green vetch and oats *ad libitum,* four pounds of rowen and three pounds each of wheat bran, Buffalo gluten feed and cotton-seed meal.

The second ration consisted of rowen *ad libitum* and three pounds each of wheat bran, Buffalo gluten feed and new-process linseed meal.

The third ration consisted of four pounds of rowen, all the corn fodder the animal could eat, and three pounds each of wheat bran, Buffalo gluten feed and new-process linseed meal.

The vetch and oats were cut when in bloom, and the corn fodder when the kernels were beginning to glaze.

Four pounds of rowen were fed daily in connection with the green fodder. The daily consumption of green fodder was governed by the individual appetite of the animals, and usually decreased with the advancing stage of growth of the fodder plant. The feeding of the green crops ceased as soon as they neared maturity, and they were then cut and made into hay, or, in the case of corn fodder, placed in the silo.

The cows were grades of various description, and the general management of the experiment was the same as in the one immediately preceding.

History of Cows.

Name of Cow.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at Beginning of Trial (Quarts).	Number of Months on Trial.
Jennie, .	Grade Jersey, .	4	Dec. 25, 1892, .	8–9	7
Gem, .	Grade Shorthorn,	5	Dec. 6, 1891, .	7–8	17
Florence, .	Grade Shorthorn,	7	May 13, 1892, .	9–10	14
Julia, .	Native, . . .	9	Jan. 18, 1893, .	9–10	6
Nora, .	Grade Ayrshire, .	5	Mar. 25, 1893, .	10–11	4
Nettie, .	Grade Holstein, .	5	July 2, 1893, .	15–16	–

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran, ...	$18 00
Buffalo gluten feed, ...	19 00
Cotton-seed meal, ...	28 00
New-process linseed meal, ...	26 00
Rowen, ...	15 00
Vetch and oats (green), ...	2 75
Corn fodder (green), ...	2 50

Analyses of the Various Articles of Fodder used.

Fodder Analyses.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal.	Rowen.	Vetch and Oats.	Corn Fodder.
Moisture at 100° C., .	12.00	9.38	8.71	10.62	11.30	79.16	80.89
Dry matter, . .	88.00	90.62	91.29	89.38	88.70	20.84	19.11
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash, . . .	7.70	0.98	7.62	5.89	6.48	8.80	6.29
" cellulose, .	11.10	8.06	8.28	8.84	29.98	30.34	26.38
" fat, . . .	5.80	14.47	9.50	3.94	4.23	3.90	1.75
" protein, . .	17.83	25.79	43.56	40.79	12.11	13.27	6.05
Non-nitrogenous extract matter, . .	57.57	50.70	31.04	40.54	47.20	43.69	59.53
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal.	Rowen.	Vetch and Oats.	Corn Fodder.
Moisture, ...	12.00	9.38	8.71	10.62	11.30	79.16	80.89
Nitrogen, ...	2.51	3.74	6.36	5.84	1.72	0.44	0.19
Phosphoric acid, .	2.85	0.46	3.17	1.95	0.47	0.13	0.15
Potassium oxide, .	1.63	0.10	2.25	1.08	1.63	0.42	0.33
Valuation per 2,000 pounds, . . .	$13 39	$13 64	$27 90	$23 58	$8 28	$2 13	$1 17
Manurial value obtainable, . . .	10 71	10 91	22 32	18 64	6 62	1 70	0 94

Average Composition of the Daily Fodder Rations used during the Three Successive Feeding Periods.

I.

July 13 to July 24.

Wheat bran, ...	3 lbs.
Buffalo gluten feed, ...	3 "
Cotton-seed meal, ...	3 "
Rowen, ...	4 "
Vetch and oats, ...	40 "
Nutritive ratio, ...	1:3.79
Total cost, ...	18.25 cts.
Manurial value obtainable,	11.32 "
Net cost, ...	6.93 "

II.

August 10 to August 28.

Wheat bran, ...	3 lbs.
Buffalo gluten feed, ...	3 "
New-process linseed meal, .	3 "
Rowen, ...	18 "
Nutritive ratio, ...	1:4.41
Total cost, ...	22.95 cts.
Manurial value obtainable,	12.00 "
Net cost, ...	10.95 "

III.

September 4 to September 28.

Wheat bran, ...	3 lbs.
Buffalo gluten feed, ...	3 "
New-process linseed meal, ...	3 "
Rowen, ...	4 "
Corn fodder, ...	55 "
Nutritive ratio, ...	1:5.06
Total cost, ...	19.33 cts.
Manurial value obtainable, ...	9.95 "
Net cost, ...	9.38 "

Summary of Cost of the Average Daily Fodder Rations.

[Cents.]

	Feeding Periods.		
	I.	II.	III.
Total cost,	18.25	22.95	19.33
Manurial value obtainable,	11.32	12.00	9.95
Net cost,	6.93	10.95	9.38

Quantity of Milk produced per Day, and Cost of Same per Quart.

Feeding Periods.	Jennie.		Gem.		Florence.		Julia.		Nora.		Nettie.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
I.,	7.36	2.40	6.87	2.75	9.37	2.02	9.00	1.96	9.64	1.83	–	–
II.,	7.12	3.22	8.94	2.41	7.02	3.28	8.95	2.54	9.02	2.55	14.27	1.61
III.,	6.43	2.81	8.40	2.18	6.01	3.09	8.26	2.19	8.89	2.09	15.83	1.25

Composition of Milk produced.

Feeding Periods.	Rations.	Jennie.		Gem.		Florence.		Julia.		Nora.		Nettie.	
		Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.
I. Ten days,	Wheat bran, Buffalo gluten feed, cotton-seed meal, rowen and vetch and oats,	15.01	5.55	13.75	3.95	13.59	4.83	13.39	4.85	13.18	4.08	-	-
		15.01	5.55	13.75	3.95	13.59	4.83	13.39	4.85	13.18	4.08	-	-
II. Eighteen days,	Wheat bran, Buffalo gluten feed, new-process linseed meal and rowen,	14.54	4.28	13.56	4.76	14.28	4.83	13.72	4.30	13.07	3.89	12.37	3.56
		14.55	5.06	12.80	4.08	13.81	4.81	13.62	4.72	13.46	4.78	12.63	3.86
		14.54	4.67	13.18	4.42	14.04	4.82	13.67	4.51	13.26	4.34	12.50	3.71
III. Twenty four days,	Wheat bran, Buffalo gluten feed, new-process linseed meal, rowen and corn fodder,	15.87	6.09	13.77	4.64	14.75	5.11	14.78	5.38	13.58	-	12.60	3.80
		15.49	5.10	13.55	3.85	14.09	4.05	14.48	4.35	13.47	3.30	12.59	3.30
		15.16	5.61	13.18	4.00	-	-	14.67	4.80	12.27	2.65	12.68	3.65
		15.84	5.60	13.50	4.16	14.42	4.58	14.64	4.84	13.11	2.98	12.62	3.58

Results of the Experiment.

There is a gradual decline in the yield of milk in case of four out of the six cows, owing to a rather advanced period of lactation. Nevertheless, it is to be observed that all three rations produced a very fair yield of milk, but the cost of the same differs. The average cost per quart for the six cows in the second feeding period, where rowen was the coarse feed, was 2.60 cents. In the first feeding period, where green vetch and oats was the chief coarse fodder, the average cost in case of five cows was 2.19 cents per quart; while in the third period, where green fodder corn was the chief coarse fodder, the average cost for the six cows was 2.30 cents per quart. In case, therefore, of feeding periods I. and III., milk is produced at an average price of 2¼ cents per quart, which is fairly low, considering the advanced period of lactation of three of the cows. In feeding period II., on the other hand, the milk cost 2.60 cents per quart, which shows that other cheaper coarse fodders must be substituted for the costly hay in order to produce milk at a minimum cost.

As far as the effect of feed upon the quality of the milk is concerned, there appears to be no distinct steady increase or decrease in composition. Variations are noticeable, generally slight ones, from week to week in the composition of each cow's milk. In one or two cases these differences are quite marked, being as high as one per cent. in case of fat; but it is plainly evident that such variations are brought about by the condition of the animal, and not by particular influence of the feed.

The results in previous years, with soja-bean, Southern cow-pea, serradella, green rye and peas and oats have already been published. They point out clearly the fact that a well-regulated system of feeding the dairy stock during the summer is necessary in order to secure the most satisfactory results.

FEEDING RECORD.

Jennie.

Feeding Periods.	Feed consumed (Pounds) per Day.							Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal.	Rowen.	Vetch and Oats.	Corn Fodder.					
1893.												
July 13 to July 24,	3.00	3.00	3.00	–	4.00	36.00	–	19.15	7.36	2.60	1:3.70	750
Aug. 10 to Aug. 28,	3.00	3.00	–	3.00	18.00	–	–	24.01	7.12	3.37	1:4.41	763
Sept. 4 to Sept. 28,	3.00	3.00	–	3.00	4.00	–	47.71	20.71	6.43	3.22	1:5.00	734
Gem.												
July 13 to July 24,	3.00	3.00	3.00	–	4.00	45.00	–	21.02	6.87	3.06	1:3.85	1,090
Aug. 10 to Aug. 28,	3.00	3.00	–	3.00	16.83	–	–	22.97	8.94	2.57	1:4.36	998
Sept. 4 to Sept. 28,	3.00	3.00	–	3.00	4.00	–	49.54	21.06	8.40	2.51	1:5.00	983
Florence.												
July 13 to July 24,	3.00	3.00	3.00	–	4.00	45.00	–	21.02	9.37	2.24	1:3.85	1,005
Aug. 10 to Aug. 28,	3.00	3.00	–	3.00	18.00	–	–	24.01	7.02	3.42	1:4.41	1,020
Sept. 4 to Sept. 28,	3.00	3.00	–	3.00	4.00	–	51.43	21.42	6.07	3.53	1:5.00	1,044

Julia.

July 13 to July 24, . . .	3.00	3.00	3.00	–	4.00	36.00	–	19.15	9.00	2.13	1:3.70	795
Aug. 10 to Aug. 28, . . .	3.00	3.00	–	3.00	17.72	–	–	23.76	8.95	2.65	1:4.40	808
Sept. 4 to Sept. 28, . . .	3.00	3.00	–	3.00	4.00	–	48.10	20.78	8.26	2.52	1:5.00	818

Nora.

July 13 to July 24, . . .	3.00	3.00	3.00	–	4.00	36.00	–	19.15	9.64	1.99	1:3.70	740
Aug. 10 to Aug. 28, . . .	3.00	3.00	–	3.00	18.00	–	–	24.01	9.02	2.66	1:4.41	748
Sept. 4 to Sept. 28, . . .	3.00	3.00	–	3.00	4.00	–	51.80	21.49	8.89	2.42	1:5.00	762

Nettie.

Aug. 10 to Aug. 28, . . .	3.00	3.00	–	3.00	18.00	–	–	24.01	14.27	1.68	1:4.41	811
Sept. 4 to Sept. 28, . . .	3.00	3.00	–	3.00	4.00	–	59.15	22.89	15.83	1.45	1:5.10	831

TOTAL COST OF FEED PER QUART OF MILK.

Jennie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Linseed Meal consumed (Pounds).	Rowen consumed (Pounds).	Green Vetch and Oats consumed (Pounds).	Corn Fodder consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk (Cents).
1893.											
July 13 to July 24, . .	80.96	7.36	33.00	33.00	33.00	–	44.00	396.00	–	$1 94	2.40
Aug. 10 to Aug. 28, . .	128.16	7.12	54.00	54.00	–	54.00	324.00	–	–	4 13	3.22
Sept. 4 to Sept. 28, . .	154.32	6.43	72.00	72.00	–	72.00	96.00	–	1,145.00	4 34	2.81

Gem.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Linseed Meal consumed (Pounds).	Rowen consumed (Pounds).	Green Vetch and Oats consumed (Pounds).	Corn Fodder consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk (Cents).
July 13 to July 24, . .	75.57	6.87	33.00	33.00	33.00	–	44.00	495.00	–	$2 08	2.76
Aug. 10 to Aug. 28, . .	160.92	8.94	54.00	54.00	–	54.00	303.00	–	–	3 97	2.47
Sept. 4 to Sept. 28, . .	201.60	8.40	72.00	72.00	–	72.00	96.00	–	1,189.00	4 39	2.18

Florence.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield of Milk (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Linseed Meal consumed (Pounds).	Rowen consumed (Pounds).	Green Vetch and Oats consumed (Pounds).	Corn Fodder consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk (Cents).
July 13 to July 24, . .	103.07	9.37	33.00	33.00	33.00	–	44.00	495.00	–	$2 08	2.02
Aug. 10 to Aug. 28, . .	126.36	7.02	54.00	54.00	–	54.00	324.00	–	–	4 43	3.27
Sept. 4 to Sept. 19, . .	91.05	6.07	45.00	45.00	–	45.00	60.00	–	763.00	2 82	3.09

Julia.

July 13 to July 24, . .	99.00	9.00	33.00	33.00	33.00	–	44.00	396.00	–	$1 94	1.96
Aug. 10 to Aug. 28, . .	161.10	8.95	54.00	54.00	–	54.00	319.00	–	–	4 09	2.54
Sept 4 to Sept. 28, . .	198.24	8.26	72.00	72.00	–	72.00	96.00	–	1,154.00	4 35	2.19

Nora.

July 13 to July 24, . .	106.04	9.64	33.00	33.00	33.00	–	44.00	396.00	–	$1 94	1.83
Aug. 10 to Aug. 28, . .	162.36	9.02	54.00	54.00	–	54.00	324.00	–	–	4 13	2.54
Sept. 4 to Sept. 28, . .	213.36	8.89	72.00	72.00	–	72.00	96.00	–	1,243.00	4 46	2.09

Nettie.

Aug. 10 to Aug. 28, . .	256.86	14.27	54.00	54.00	–	54.00	324.00	–	–	$4 13	1.61
Sept. 4 to Sept. 28, . .	379.92	15.83	72.00	72.00	–	72.00	96.00	–	1,419.00	4 68	1.23

3. Creamery Record of the Station for 1892 and 1893.

The cost of feed consumed is based on the market prices stated below. The valuation of the whole milk is taken at three cents per quart.

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$19 00
Buffalo gluten feed,	20 00
Cotton-seed meal,	28 00
New-process linseed meal,	26 00
Hay,	15 00
Rowen,	15 00
Corn fodder (green),	2 50
Corn stover,	5 00
Corn and soja-bean ensilage,	2 75
Soja-bean and corn ensilage,	2 75
Serradella and Hungarian grass ensilage,	2 75
Hay of peas and oats,	15 00
Hay of vetch and oats,	15 00
Vetch and oats (green),	2 50
Buckwheat (green),	2 50
Vetch (green),	3 00
Globe mangolds,	4 00

Fertilizing Constituents.

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5½ cents, per pound.]

	Moisture.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per 2,000 Pounds.
Wheat bran,	11.17	2.48	2.85	1.63	$13 31
Buffalo gluten feed,	8.83	3.78	0.05	0.10	13 80
Cotton-seed meal,	7.85	6.47	2.75	1.98	27 57
New-process linseed meal,	10.62	5.84	1.95	1.08	23 58
Hay,	9.00	1.52	0.35	1.54	7 36
Rowen,	11.30	1.72	0.47	1.63	8 28
Corn fodder (green),	80.89	0.19	0.15	0.33	1 17
Corn stover,	14.66	0.55	3.23	1.84	7 17
Corn and soja-bean ensilage,	77.77	0.32	0 12	0.48	1 77
Soja-bean and corn ensilage,	80.33	0.27	0.12	0.48	1 59
Serradella and Hungarian grass ensilage,	80.83	0.45	0.12	0.48	2 22
Hay of peas and oats,	12.30	2.24	0.65	2.10	10 80
Hay of vetch and oats,	9.95	2.44	0.65	2.10	11 50
Vetch and oats (green),	79.16	0.44	0.13	0.42	2 13
Buckwheat (green),	85.00	0.39	0.08	0.38	1 86
Vetch (green),	82.00	0.56	0.21	0.17	2 35
Globe mangolds,	88.51	0.13	0.10	0.47	1 07

Fertilizing Constituents of Cream.

[Average Analysis.]

	Per Cent.
Moisture at 100° C.,	72.00–74.00
Nitrogen (17½ cents per pound),	0.54
Phosphoric acid (5 cents per pound),	0.17
Potassium oxide (5½ cents per pound),	0.12

The monthly value placed upon the cream is the price paid for the same by the local creamery. The financial statement is based on the local cost of feed, and does not take into consideration interest on investment or cost of labor involved.

The results here presented are stated under the following separate headings: —

1. Statement of articles of fodder used.
2. Record of average quality of milk and fodder rations.
3. Value of cream at creamery basis of valuation.
4. Cost of skim-milk on the basis of three cents per quart for whole milk.
5. What the creamery records show.
6. Analyses of cream and butter fat.

1. Statement of Articles of Fodder used during 1892 (Pounds).

1892.	Wheat Bran.	Gluten Feed.	Maize Feed.	Cotton-seed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Green Rye.	Canada Peas and Oats.	Vetch.	Vetch and Oats.	Rape.	Serradella.	Sugar Beets.	Cabbages.
January, . .	523.50	-	523.50	523.50	570.00	-	-	714.00	3,768.00	-	-	-	-	-	-	-	-
February, .	516.00	-	516.00	516.00	870.00	-	-	-	6,292.00	-	-	-	-	-	-	-	-
March, . .	549.00	150.00	396.00	549.00	870.00	615.00	-	-	4,604.00	-	-	-	-	-	-	840.00	-
April, . .	450.00	450.00	-	450.00	-	2,250.00	-	-	-	-	-	-	-	-	-	2,250.00	-
May, . . .	465.00	465.00	-	465.00	-	1,855.00	-	-	-	850.00	-	-	-	-	-	1,500.00	-
June, . .	540.00	540.00	-	540.00	-	900.00	-	-	-	1,254.00	2,220.00	-	540.00	-	-	-	-
July, . .	558.00	558.00	-	558.00	-	930.00	-	-	-	-	-	-	6,776.00	-	-	-	-
August, . .	558.00	558.00	-	558.00	-	930.00	6,102.00	-	-	-	-	1,380.00	-	882.00	-	-	2,016.00
September, .	540.00	540.00	-	540.00	-	900.00	7,781.00	-	-	-	-	-	-	297.00	2,130.00	-	-
October, . .	558.00	558.00	-	558.00	-	270.00	1,119.00	-	-	-	-	-	-	162.00	1,008.00	-	180.00
November, .	540.00	540.00	-	540.00	2,575.00	-	-	-	-	-	-	-	-	-	-	1,980.00	-
December, .	558.00	558.00	-	558.00	315.00	-	-	2,159.00	-	-	-	-	-	-	-	540.00	-

1. *Statement of Articles of Fodder used during 1893 (Pounds).*

1893.	Wheat Bran.	Buffalo Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Serradella and Hungarian Grass Ensilage.	Peas and Oats (Dry).	Vetch and Oats (Dry).	Vetch and Oats (Green).	Buckwheat (Green).	Vetch (Green).
January, . . .	489.00	489.00	442.00	-	1,080.00	-	-	742.50	2,968.50	-	-	-	-	-	-	-
February, . .	504.00	504.00	491.00	-	798.00	-	-	-	7,084.00	-	-	-	-	-	-	-
March, . . .	516.00	516.00	507.00	-	721.00	-	-	-	9,103.00	-	-	-	-	-	-	-
April, . . .	507.00	507.00	426.00	-	781.00	-	-	-	2,530.00	1,370.00	4,751.00	-	-	-	-	-
May, . . .	555.00	555.00	555.00	-	753.00	-	-	-	-	9,233.00	-	-	448.00	-	-	-
June, . . .	540.00	540.00	540.00	-	-	942.00	-	-	-	-	-	1,564.00	184.00	-	-	-
July, . . .	558.00	558.00	409.50	130.50	-	1,820.00	-	-	-	-	-	-	-	3,880.00	-	-
August, . . .	558.00	558.00	-	558.00	-	2,726.00	-	-	-	-	-	-	-	-	633.00	252.00
September, . .	531.00	531.00	-	519.00	264.00	636.00	948.00	-	-	-	-	-	-	-	-	-
October, . . .	558.00	558.00	-	558.00	1,757.00	-	7,818.00	-	-	-	-	-	-	-	-	-

2. *Record of Average Quality of Milk and of Fodder Rations (1892).*

1892.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	Feed consumed (Pounds) per Day.													
					Wheat Bran.	Gluten Feed.	Maize Feed.	Cotton-seed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Green Rye.	Canada Peas and Oats.	Vetch and Oats.	Serradella.	Sugar Beets.
January,	13.75	4.55	1.73	1:4.63 –	3.00 3.00	– –	3.00 3.00	3.00 3.00	– 5.00	– –	– –	12.06 –	– 32.00	– –	– –	– –	– –	– –
February,	13.24	4.36	1.70	1:4.64	3.00	–	3.00	3.00	5.00	–	–	–	32.00	–	–	–	–	–
March,	12.98	4.10	1.58	1:4.81	3.00	–	3.00	3.00	5.00	–	–	–	41.39	–	–	–	–	–
April,	13.09	4.01	1.72	1:4.48	3.00	3.00	–	3.00	–	15.00	–	–	–	–	–	–	–	15.00
May,	13.00	3.92	1.77	1:4.80	3.00	3.00	–	3.00	–	15.00	–	–	–	–	–	–	–	15.00
June,	13.43	4.28	2.09	1:3.78 1:3.70	3.00 3.00	3.00 3.00	– –	3.00 3.00	– –	5.00 5.00	– –	– –	– –	16.22 –	– 27.50	– –	– –	– –
July,	12.80	3.73	1.82	1:3.76	3.00	3.00	–	3.00	–	5.00	–	–	–	–	–	37.71	–	–
August,	12.30	3.50	2.08	1:5.00	3.00	3.00	–	3.00	–	5.00	50.00	–	–	–	–	–	–	–
September,	12.55	3.66	1.88	1:5.70 1:4.60	3.00 3.00	3.00 3.00	– –	3.00 3.00	– –	5.00 5.00	70.00 30.00	– –	– –	– –	– –	– –	– 20.00	– –
October,	13.17	3.77	1.85	1:5.22 1:4.50	3.00 3.00	3.00 3.00	– –	3.00 3.00	– 15.00	– –	30.00 –	– –	– –	– –	– –	– –	20.00 –	– –
November,	13.45	3.85	1.86	1:4.90	3.00	3.00	–	3.00	14.19	–	–	–	–	–	–	–	–	15.00
December,	13.66	4.33	1.80	1:4.80	3.00	3.00	–	3.00	–	–	–	15.00	–	–	–	–	–	15.00
Averages,	13.12	4.01	1.82	1:4.95														

2. *Record of Average Quality of Milk and of Fodder Rations (1893).*

1893.	Average Percentage of Solids in Milk.	Average Percentage of Fat in Milk.	Quarts of Milk required to make One Space of Cream.	Nutritive Ratio of Feed.	Feed consumed (Pounds) per Day.													
					Wheat Bran.	Gluten Feed.	Cotton-seed Meal.	New-process Linseed Meal	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Serradella and Hungarian Grass Ensilage.	Peas and Oats (Dry).	Vetch and Oats (Dry).	Vetch and Oats (Green).
January, ...	13.80	4.77	1.66	1:4.80 1:4.00	3.00 3.00	3.00 3.00	3.00 3.00	- -	- 9.47	- -	- -	15.00 -	- 22.48	- -	- -	- -	- -	- -
February, ...	13.82	4.73	1.70	1:4.80	3.00	3.00	3.00	-	4.75	-	-	-	42.16	-	-	-	-	-
March, ...	14.01	4.71	1.75	1:4.80	3.00	3.00	3.00	-	4.00	-	-	-	46.68	-	-	-	-	-
April, ...	13.73	4.67	1.93	1:4.90 1:4.50	3.00 3.00	3.00 3.00	3.00 1.00	- -	4.00 4.00	- -	- -	- -	50.00 -	- -	- 50.00	- -	- -	- -
May, ...	13.74	4.51	1.94	1:5.00 1:3.50	3.00 3.00	3.00 3.00	3.00 3.00	- -	4.00 -	- -	- -	- -	- -	54.95 -	- -	- -	- 12.50	- -
June, ...	13.81	4.42	1.83	1:3.60 1:4.40	3.00 3.00	3.00 3.00	3.00 3.00	- -	- -	- 16.00	- -	- -	- -	- -	- -	15.60 -	- -	- -
July, ...	13.67	4.52	1.81	1:4.40 1:3.79	3.00 3.00	3.00 3.00	3.00 3.00	- -	- -	16.00 4.00	- -	- -	- -	- -	- -	- -	- -	- 40.00
August, ...	13.64	4.52	2.00	1:4.50	3.00	3.00	-	3.00	-	18.00	-	-	-	-	-	-	-	-
September, . . .	13.96	4.53	1.98	1:4.90	3.00	3.00	-	3.00	-	4.00	46.00	-	-	-	-	-	-	-
October, ...	14.01	4.84	1.99	1:4.50 1:3.79	3.00 3.00	3.00 3.00	- -	3.00 3.00	17.60 -	- -	- -	- -	- -	- -	- -	- -	- 16.00	- -
Averages, . . .	13.82	4.62	1.86	1:4.38														

3. *Value of Cream at Creamery Basis of Valuation.*

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1892.					
January,	$31 07	$17 51	$0 55	$14 11	$34 64
February,	34 38	18 36	0 62	16 64	38 95
March,	38 50	20 95	0 76	18 31	45 04
April,	38 47	21 04	0 65	18 08	36 59
May,	35 23	20 13	0 67	15 77	31 65
June,	31 28	19 44	0 57	12 41	27 50
July,	36 11	22 80	0 58	13 89	28 69
August,	39 94	23 95	0 56	16 57	32 22
September,	38 95	22 93	0 55	16 57	33 72
October,	40 12	22 14	0 57	18 55	34 84
November,	43 33	21 29	0 45	22 49	31 00
December,	28 91	17 03	0 41	12 29	29 02
Averages,	$36 36	$20 63	$0 57	$16 31	$33 65
1893.					
January,	$30 41	$22 81	$0 67	$7 27	$41 69
February,	32 44	20 05	0 80	13 19	49 39
March,	35 07	24 91	0 91	11 07	56 32
April,	33 59	25 42	0 70	8 87	41 24
May,	40 29	27 98	0 70	13 01	38 95
June,	38 27	28 48	0 62	10 41	32 80
July,	36 81	26 34	0 61	10 58	31 57
August,	40 31	26 74	0 60	14 17	31 32
September,	33 61	18 99	0 55	15 17	32 88
October,	41 57	28 68	0 61	13 50	34 84
Averages,	$36 24	$25 08	$0 68	$11 72	$39 10

4. Cost of Skim-milk on the Basis of Three Cents per Quart for Whole Milk.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim-milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
1892.									
January, .	1,460.3	845.0	248.5	1,211.8	4.10	2.38	$34 64	0.75	$9 16
February, .	1,612.4	950.0	279.4	1,333.0	4.10	2.42	38 95	0.71	9 42
March, . .	1,818.0	1,155.0	340.0	1,478.0	3.90	2.45	45 04	0.65	9 50
April, . .	1,704.4	989.0	290.9	1,413.5	3.70	2.14	36 59	1.03	14 54
May, . .	1,806.7	1,021.0	300.0	1,506.7	3.10	1.73	31 65	1.50	22 55
June, . .	1,818.5	873.0	256.8	1,561.7	3.15	1.51	27 50	1.73	27 05
July, . .	1,602.8	883.0	260.0	1,342.8	3.25	1.78	28 69	1.44	19 40
August, . .	1,765.8	848.0	249.4	1,516.4	3.80	1.80	32 22	1.36	20 76
September, .	1,581.4	843.0	248.0	1,333.4	4.00	2.12	33 72	1.03	13 71
October, . .	1,614.7	871.0	256.2	1,358.5	4.00	2.16	34 84	1.00	13 61
November, .	1,408.7	756.0	222.3	1,186.4	4.10	2.20	31 00	0.94	11 26
December, .	1,232.0	691.0	203.2	1,028.8	4.20	2.35	29 02	0.64	7 94
Averages, .	1,618.8	893.8	262.8	1,357.6	3.78	2.09	$33 66	1.07	$14 83
1893.									
January, .	1,625.2	981.0	288.5	1,336.5	4.25	2.57	$41 69	0.53	$7 06
February, .	2,007.4	1,176.0	345.9	1,651.5	4.20	2.46	49 39	0.66	10 83
March, . .	2,332.5	1,341.0	394.4	1,938.1	4.20	2.41	56 32	0.70	13 65
April, . .	2,008.7	1,031.0	303.2	1,705.5	4.00	2.05	41 24	1.11	19 02
May, . .	1,997.6	1,025.0	301.5	1,696.1	3.80	1.98	38 95	1.24	20 97
June, . .	1,668.6	911.0	267.9	1,400.7	3.60	1.96	32 80	1.23	17 25
July, . .	1,632.2	902.0	265.3	1,366.9	3.50	1.93	31 57	1.16	17 39
August, . .	1,743.9	870.0	258.9	1,495.0	3.60	1.61	31 32	1.41	20 99
September, .	1,605.6	822.0	241.8	1,363.8	4.00	2.04	32 88	1.12	15 28
October, . .	1,830.9	901.0	265.0	1,565.9	4.00	1.97	34 84	1.20	18 89
Averages, .	1,845.3	996.0	293.2	1,552.0	3.91	2.09	$39 10	1.03	$16 13

5. What the Creamery Records Show.

1. The nutritive ratio of the feed varied in 1892 from 1 : 3.70 to 1 : 5.70, with an average of 1 : 4.95 ; in 1893 from 1 : 3.50 to 1 : 5.00, with an average of 1 : 4.38.

2. The average monthly percentage of fat in the milk varied in 1892 from 3.50 to 4.55, with an average of 4.01 ; in 1893, from 4.42 to 4.84, with an average of 4.62.

3. The average monthly percentage of total solids varied in 1892 from 12.30 to 13.75, with an average of 13.12; in 1893, from 13.64 to 14.01, with an average of 13.82.

4. The relation of fat to solids not fat in 1892 was 1 : 2.29, while in 1893 it was 1 : 1.99.

5. The total cost of feed for one quart of cream amounted in 1892 to 13.84 cents and in 1893 to 12.36 cents.

6. The net cost of feed for one quart of cream amounted in 1892 to 6.21 cents and in 1893 to 4.00 cents.

7. The value received for one space of cream varied in 1892 from 3.10 to 4.20 cents, with an average of 3.78; in 1893, from 3.50 to 4.25, with an average of 3.91 cents; which amounted per quart (average) in 1892 to 12.85 cents, and in 1893 to 13.29 cents.

8. The number of quarts of milk required to produce one space of cream in 1892 was 1.81 and in 1893 1.85; or 6.16 quarts of whole milk to produce one quart of cream in 1892, and 6.29 quarts of whole milk to produceone quart of cream in 1893.

9. The net cost of feed per quart of cream averaged in 1892 6.21 cents and in 1893 4.00 cents. Received per quart of cream in 1892 12.85 cents and in 1893 13.34 cents, thereby securing a profit of 6.64 cents per quart in 1892 and 9.34 cents in 1893.

For further details concerning results in preceding years, see ninth annual report, pages 76 to 82, and tenth annual report, pages 48 to 55.

Our average statements for the current year apply in each case to only ten months, due to the fact that the financial settlement is made with our local creamery two months after the cream is furnished.

6. Creamery Record, 1892–93. — Analyses of Cream and Butter Fat.

Feeding Periods.	Date of Sampling.	Analysis of Cream.			Analysis of Fat.		Average Daily Fodder Rations.
		Solids.	Fat.	Solids not Fat.	Volatile Acids.	Non-volatile Acids.	
I.	Oct. 18,	25.63	16.00	9.63	–	–	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 15 pounds hay.
II.	Dec. 3,	25.28	16.90	8.38	–	–	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 15 pounds hay, 15 pounds sugar beets.
III.	Dec. 23,	25.55	17.00	8.55	–	–	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 15.9 pounds corn stover.
IV.	Jan. 19,	28.52	20.66	7.86	5.63	88.75	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 4 pounds hay, 48 pounds corn and soja-bean ensilage.
	Jan. 25,	26.30	18.00	8.30	5.77	87.45	
	Jan. 30,	27.50	18.83	8.67	5.57	87.42	
	Feb. 9,	27.03	18.55	8.48	5.73	87.00	
	Feb. 15,	27.19	19.55	7.64	5.48	87.33	
	Feb. 28,	28.23	20.23	8.00	5.98	86.80	
	March 6,	29.17	21.20	7.97	5.57	88.30	
	March 15,	30.00	22.25	7.75	5.39	87.15	
	March 21,	27.10	19.13	7.97	5.48	87.46	
	March 28,	26.19	18.44	7.75	5.75	86.55	
	April 4,	26.66	18.80	7.86	5.91	86.90	
V.	May 3,	27.11	19.01	8.10	5.81	87.71	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton seed meal, 4 pounds hay, 49.5 pounds soja-bean and corn ensilage.
	May 17,	25.45	17.85	7.60	5.45	87.47	
	May 23,	27.34	19.97	7.37	5.52	87.81	
VI.	June 8,	25.18	18.02	7.17	5.04	88.49	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 14.64 pounds hay of peas and oats.
	June 14,	27.31	19.08	8.23	5.38	87.45	
	June 22,	25.53	18.56	6.97	4.95	88.17	
VII.	June 28,	29.87	22.48	7.39	4.79	87.57	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 16.62 pounds rowen.
	July 5,	24.86	16.85	8.01	5.72	88.25	

6. Creamery Record, 1893. — Analyses of Cream and Butter Fat.

Feeding Periods.	Date of Sampling.	Analysis of Cream.			Analysis of Fat.		Average Daily Fodder Rations.
		Solids.	Fat.	Solids not Fat.	Volatile Acids.	Non-volatile Acids.	
I.	July 14,	31.60	23.99	7.61	–	–	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds cotton-seed meal, 4 pounds rowen, 39.60 pounds vetch and oats.
	July 19,	30.56	22.63	7.93	5.34	88.15	
II.	Aug. 12,	27.85	19.82	8.03	5.24	87.00	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds linseed meal, 17.76 pounds rowen.
	Aug. 17,	32.78	24.78	8.00	4.77	88.20	
	Aug. 22,	32.44	25.00	7.44	–	–	
III.	Sept. 5,	27.41	20.30	7.11	4.82	88.17	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds linseed meal, 4 pounds rowen, 51.29 pounds corn fodder.
	Sept. 12,	24.81	16.79	8.02	5.50	–	
	Sept. 29,	24.89	16.23	8.61	5.52	86.93	
IV.	Oct. 3,	24.63	16.01	8.62	5.88	86.79	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds linseed meal, 18 pounds hay.
	Oct. 13,	26.87	17.75	9.12	5.50	87.04	
	Oct. 20,	26.29	18.15	8.14	5.27	87.64	
V.	Oct. 25,	26.19	17.85	8.34	4.87	88.27	3 pounds wheat bran, 3 pounds gluten feed, 3 pounds linseed meal, 16 pounds hay of vetch and oats.
	Oct. 31,	24.71	16.58	8.13	5.20	87.02	

II.

FOURTH FEEDING EXPERIMENT WITH STEERS.

1892–93.

General Description.

The experiment here described is a continuation of those published in our previous reports.

Two grades Shorthorn steers, yearlings, weighing about six hundred pounds each, were used in the experiment. They were quite thin when first received, and cost 3.5 cents per pound of live weight.

The coarse foods fed were raised upon the station grounds, and consisted principally of corn ensilage, corn stover, hay, green rye and a small quantity of roots.

The corn for ensilage was cut just as the kernels were glazing. The corn stover was the corn plant remaining after the fully matured ears had been removed.

The grains used were either equal weight parts of wheat bran and Chicago maize feed or wheat bran and Buffalo gluten feed.

The quantity of coarse fodders fed depended in all cases upon the individual appetite of the animals.

The animals were fed and watered twice each day, between five and six o'clock in the morning and at five in the afternoon, one-half of the food being given at each time.

Two distinct feeding periods are described, namely, the first winter and spring seasons and the autumn and second winter seasons.

Objects of the Experiment.

The objects of the experiment were threefold : —

I. To ascertain, if possible, those rations, i. e., *combinations of food, that would produce the largest growth for the least outlay of money.*

II. To secure facts relating to the actual cost of beef production in Massachusetts under existing local conditions.

III. To compare the relative merits and cost of pasture vs. *soiling during the summer season.*

1. Feeding Record of First Winter and Spring Seasons.

Dec. 1, 1891, to June 12, 1892.

[Coarse fodders: hay, corn ensilage, corn stover, green rye, turnips, mangolds and sugar beets; grains: wheat bran, Chicago maize feed and Buffalo gluten feed.]

Local Market Cost, per Ton, of the Various Articles of Fodder used.

Wheat bran,	$22 00
Chicago maize feed,	25 00
Buffalo gluten feed,	23 00
Hay,	15 00
Dent corn ensilage,*	2 50
Sweet corn ensilage,	2 50
Dent corn stover,*	5 00
Green rye,	2 50
Turnips,	2 50
Mangolds,	4 00
Sugar beets,	5 00

* Pride of the North.

Analyses of Fine Feed used.

Fodder Analyses.	Wheat Bran.	Chicago Maize Feed.	Buffalo Gluten Feed.
Moisture at 100° C.,	10.09	8.70	7.65
Dry matter,	89.91	91.30	92.35
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	6.62	0.78	0.86
" cellulose,	11.91	7.97	5.42
" fat,	4.76	7.37	13.23
" protein,	17.55	27.75	25.95
Non-nitrogenous extract matter,	59.16	56.33	54.54
	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizing Analyses.	Wheat Bran.	Chicago Maize Feed.	Buffalo Gluten Feed.
Moisture,	10.09	8.70	7.65
Nitrogen,	2.52	4.03	3.88
Phosphoric acid,	2.85	0.30	0.30
Potassium oxide,	1.63	0.045	0.045
Valuation per 2,000 pounds,	$12 16	$12 41	$12 41
Manurial value obtainable,	11 18	11 41	11 00

Analyses of Coarse Fodders used.

Fodder Analyses.	Hay.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Dent Corn Stover.	Green Rye.	Turnips.	Mangolds.	Sugar Beets.
Moisture at 100° C.,	9.72	79.92	84.30	20.10	62.11	90.21	87.75	85.27
Dry matter,	90.28	20.08	15.70	79.90	37.89	9.79	12.25	14.73
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.								
Crude ash,	6.43	4.99	6.32	6.12	5.27	8.47	9.06	5.95
" cellulose,	32.28	27.19	29.32	33.72	21.52	11.23	7.94	6.49
" fat,	2.49	3.29	7.36	2.51	2.46	1.74	0.88	0.66
" protein,	9.54	8.29	7.86	7.75	5.38	10.12	10.37	10.97
Non-nitrogenous extract matter,	49.26	56.24	49.14	49.90	65.57	68.44	71.75	75.93
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Hay.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Dent Corn Stover.	Green Rye.	Turnips.	Mangolds.	Sugar Beets.
Moisture,	9.72	79.92	84.30	20.11	62.11	90.21	87.75	85.27
Nitrogen,	1.38	0.27	0.20	0.99	0.327	0.178	0.203	0.26
Phosphoric acid,	0.36	0.33	0.41	1.40	0.734	0.385	0.383	0.48
Potassium oxide,	1.57	0.14	0.089	0.29	0.15	0.104	0.093	0.10
Valuation per 2,000 pounds,	$5 95	$1 26	$1 06	$4 55	$1 80	$0 99	$1 06	$1 32
Manurial value obtainable,	5 47	1 16	0 97	4 19	1 66	0 91	0 97	1 21

Average Composition of the Daily Fodder Rations used during the Seven Successive Feeding Periods.

(First Winter and Spring Seasons, 1891–92.)

I.		II.	
December 1 to December 21.		*December 26 to January 12.*	
Wheat bran,	2.5 lbs.	Wheat bran,	2.5 lbs.
Chicago maize feed,	2.5 "	Chicago maize feed,	2.5 "
Hay,	8 "	Hay,	8 "
Turnips,	15 "	Mangolds,	15 "
Nutritive ratio,	1 : 5.94	Nutritive ratio,	1 : 6.06
Total cost,	13.87 cts.	Total cost,	14.87 cts.
Manurial value obtainable,	5.44 "	Manurial value obtainable,	5.64 "
Net cost,	8.43 "	Net cost,	9.23 "

III.		IV.	
January 25 to February 21.		*February 29 to March 22.*	
Wheat bran,	3 lbs.	Wheat bran,	3 lbs.
Chicago maize feed,	3 "	Chicago maize feed,	3 "
Dent corn ensilage,	35 "	Sweet corn ensilage,	47 "
Nutritive ratio,	1 : 5.4	Nutritive ratio,	1 : 5.92
Total cost,	11.42 cts.	Total cost,	12.92 cts.
Manurial value obtainable,	5.39 "	Manurial value obtainable,	5.64 "
Net cost,	6.03 "	Net cost,	7.28 "

V.		VI.	
March 28 to April 19.		*April 26 to May 20.*	
Wheat bran,	3 lbs.	Wheat bran,	3 lbs.
Chicago maize feed,	3 "	Buffalo gluten feed,	3 "
Dent corn stover,	10 "	Hay,	10 "
Nutritive ratio,	1 : 5.65	Sugar beets,	12 "
Total cost,	9.55 cts.	Nutritive ratio,	1 : 5.95
Manurial value obtainable,	5.48 "	Total cost,	17.55 cts.
Net cost,	4.07 "	Manurial value obtainable,	6.75 "
		Net cost,	10.80 "

VII.	
June 1 to June 12.	
Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "
Green rye,	23 "
Nutritive ratio,	1 : 6.9
Total cost,	9.62 cts.
Manurial value obtainable,	5.33 "
Net cost,	4.29 "

Points to be Noticed in Above.

1. The actual composition of the different rations and the general proportion which the nitrogenous matter bears to the non-nitrogenous, *i. e.*, the nutritive ratio.

2. Notice how both the total and net cost of the different rations differ, and that wherever a considerable quantity of hay is fed the cost of the ration increases.

Summary of Cost of the Above-stated Average Daily Fodder Rations.

[Cents.]

	Feeding Periods.						
	I.	II.	III.	IV.	V.	VI.	VII.
Total cost,	13.87	14.87	11.42	12.92	9.55	17.55	9.62
Manurial value obtainable,*	5.44	5.64	5.39	5.64	5.48	6.75	5.33
Net cost,	8.43	9.23	6.03	7.28	4.07	10.80	4.29

* Allowing ninety-two per cent. of the fertilizing ingredients of the feed to be recovered in the manure.

Gain required per Day in Pounds of Live Weight to cover Cost of Feed.

	Feeding Periods.						
	I.	II.	III.	IV.	V.	VI.	VII.
On total cost,	3.26	3.50	2.69	3.04	2.25	4.10	2.27
On net cost,	2.00	2.17	1.42	1.71	0.96	2.54	1.00

Live Weight actually produced per Day.

	2.21	1.77	1.78	1.15	0.70	2.00	0.87

Cost of Feed per Pound of Live Weight gained.

[Cents.]

Total cost,	6.30	8.40	6.41	11.24	13.64	8.77	11.06
Net cost,	3.83	5.20	3.38	6.33	5.81	5.40	4.96

Remarks.

These figures show that in no case have the animals gained enough in live weight to cover the total cost of the food consumed, but the weight gained was nearly sufficient to cover the net cost of the feed.

Considering the merits of the different rations as far as their relative cost and productive capacity are concerned, the results are at least instructive.

Notice, first, that the larger the amount of hay fed the higher the cost of the daily ration. In this experiment, however, a moderate amount of hay in combination with roots and grains has produced beef at a fairly low price. Ration number III., consisting of ensilage and grains, has also given very favorable results. In the latter case the total cost of feed per pound of live weight gained was 6.35 cents and the net cost 3.38 cents. Many experiments have demonstrated the fact that corn ensilage, when fed in combination with concentrated feeds high in protein, produces beef at as low a cost as any other known coarse fodder article, and it proves itself an excellent fodder for winter feeding.

Steer No. 1.

Feeding Periods.	Feed consumed (Pounds) per Day.																
	Wheat Bran.	Chicago Maize Feed.	Buffalo Gluten Feed.	Hay.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Dent Corn Stover.	Green Rye.	Turnips.	Mangolds.	Sugar Beets.	Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).	Dry Matter required to produce One Pound of Live Weight (Pounds).
1891-92.																	
Dec. 1 to Dec. 21,	2.5	2.5	-	9.0	-	-	-	-	15.0	-	-	14.13	1 : 5.94	588	650	3.00	4.71
Dec. 26 to Jan. 12,	2.5	2.5	-	8.7	-	-	-	-	-	13.8	-	14.06	1 : 6.06	650	695	2.00	7.03
Jan. 25 to Feb. 21,	3.0	3.0	-	-	35.0	-	-	-	-	-	-	12.44	1 : 5.40	700	750	1.80	6.91
Feb. 29 to March 22,	3.0	3.0	-	-	-	44.0	-	-	-	-	-	12.34	1 : 5.90	750	780	1.30	9.50
March 28 to April 19,	3.0	3.0	-	-	-	-	9.0	-	-	-	-	12.64	1 : 5.65	774	785	0.50	25.30
April 26 to May 20,	3.0	-	3.0	10.0	-	-	-	-	-	-	12.0	16.30	1 : 5.95	812	860	2.00	8.15
June 1 to June 12,	3.0	-	3.0	-	-	-	-	24.0	-	-	-	14.56	1 : 6.90	870	885	1.25	11.64

	Pounds.
Live weight of animal at the beginning of the experiment,	588.00
Live weight of animal at the close of the experiment,	885.00
Live weight gained during the experiment,	297.00
Average gain in weight per day,	1.52

Steer No. 2.

Feeding Periods.	Feed consumed (Pounds) per Day.											Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).	Dry Matter required to produce One Pound of Live Weight (Pounds).
	Wheat Bran.	Chicago Maize Feed.	Buffalo Gluten Feed.	Hay.	Dent Corn Ensilage.	Sweet Corn Ensilage.	Dent Corn Stover.	Green Rye.	Turnips.	Mangolds.	Sugar Beets.						
1891-92.																	
Dec. 1 to Dec. 21,	2.5	2.5	–	7.3	–	–	–	–	15.0	–	–	12.59	1 : 5.94	600	631	1.50	8.40
Dec. 26 to Jan. 12,	2.5	2.5	–	8.9	–	–	–	–	–	13.8	–	13.42	1 : 6.06	649	683	1.55	8.70
Jan. 25 to Feb. 21,	3.0	3.0	–	–	35.0	–	–	–	–	–	–	12.44	1 : 5.40	700	750	1.80	7.00
Feb. 29 to March 22,	3.0	3.0	–	–	–	53.0	–	–	–	–	–	13.76	1 : 5.92	776	800	1.00	13.76
March 28 to April 19,	3.0	3.0	–	–	–	–	9.0	–	–	–	–	12.64	1 : 5.65	770	792	1.00	12.64
April 26 to May 20,	3.0	–	3.0	10.0	–	–	–	–	–	–	12.0	16.30	1 : 5.95	825	874	2.00	8.15
June 1 to June 12,	3.0	–	3.0	–	–	–	–	22.5	–	–	–	15.02	1 : 6.90	865	871	0.50	30.04

	Pounds.
Live weight of animal at the beginning of the experiment,	600.00
Live weight of animal at the close of the experiment,	871.00
Live weight gained during the experiment,	271.00
Average gain in weight per day,	1.39

2. Feeding Record of Autumn and Second Winter Seasons.

Sept. 5, 1892, to Feb. 28, 1893.

[Corn fodders: green fodder corn, green serradella, corn stover and corn and soja-bean ensilage; grains: wheat bran and Buffalo gluten feed.]

Local Market Cost per Ton of the Various Articles of Fodder used.

Wheat bran,	$20 00
Buffalo gluten feed,	21 00
Fodder corn (green),	2 50
Serradella (green),	2 75
Corn stover,	5 00
Corn and soja-bean ensilage,	2 75

Analyses of the Various Articles of Fodder used.

Fodder Analyses.	Wheat Bran.	Buffalo Gluten Feed.	Fodder Corn.	Serradella.	Corn Stover.	Corn and Soja-bean Ensilage.
Moisture at 100° C.,	8.71	7.18	68.53	82.03	14.66	77.77
Dry matter,	91.29	92.82	31.47	17.97	85.34	22.23
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	7.08	0.84	5.68	9.59	5.49	9.48
" cellulose,	12.10	7.50	23.00	26.28	37.57	26.63
" fat,	5.64	12.75	2.81	2.59	1.82	3.75
" protein,	17.73	26.28	6.22	15.13	4.00	7.91
Non-nitrogenous extract matter,	57.45	52.63	62.30	46.41	51.02	52.23
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Buffalo Gluten Feed.	Fodder Corn.	Serradella.	Corn Stover.	Corn and Soja-bean Ensilage.
Moisture,	8.71	7.18	68.53	82.03	14.66	77.77
Nitrogen,	2.42	4.25	0.31	0.43	0.55	0.32
Phosphoric acid,	2.85	0.30	0.05	1.26	0.23	0.12
Potassium oxide,	1.63	0.04	0.15	0.38	1.84	0.48
Valuation per 2,000 pounds,	$11 86	$13 13	$1 12	$1 78	$3 55	$1 52
Manurial value obtainable,	10 90	12 07	1 03	1 63	3 26	1 40

Average Composition of the Daily Fodder Rations used during the Four Successive Feeding Periods.

(Autumn and Second Winter Seasons, 1892–93.)

I.		II.	
September 5 to September 12.		*September 17 to September 28.*	
Wheat bran,	3 lbs.	Wheat bran,	3 lbs.
Buffalo gluten feed,	3 "	Buffalo gluten feed,	3 "
Fodder corn,	70 "	Fodder corn,	40 "
Nutritive ratio,	1 : 8.70	Serradella,	20 "
Total cost,	14.90 cts.	Nutritive ratio,	1 : 6.60
Manurial value obtainable,	7.00 "	Total cost,	13.89 cts.
Net cost,	7.90 "	Manurial value obtainable,	7.10 "
		Net cost,	6.79 "
III.		**IV.**	
December 1 to January 9.		*January 16 to February 28.*	
Wheat bran,	3 lbs.	Wheat bran,	4 lbs.
Buffalo gluten feed,	3 "	Buffalo gluten feed,	4 "
Corn stover,	13 "	Corn and soja-bean ensilage,	43 "
Nutritive ratio,	1 : 8.00	Nutritive ratio,	1 : 5.80
Total cost,	9.40 cts.	Total cost,	13.57 cts.
Manurial value obtainable,	5.55 "	Manurial value obtainable,	7.60 "
Net cost,	3.85 "	Net cost,	5.97 "

Summary of Cost of the Above-stated Average Daily Fodder Rations.

[Cents.]

	Feeding Periods.			
	I.	II.	III.	IV.
Total cost,	14.90	13.89	9.40	13.57
Manurial value obtainable,*	7.00	7.10	5.55	7.60
Net cost,	7.90	6.79	3.85	5.97

* Allowing ninety-two per cent. of the fertilizing ingredients of the feed to be recovered in the manure.

Gain required per Day in Pounds of Live Weight to cover Cost of Feed.

	Feeding Periods.			
	I.	II.	III.	IV.
Total cost, ...	3.50	3.27	2.21	3.19
Net cost, ...	1.86	1.60	0.91	1.40

Live Weight actually produced per Day.

	–*	–*	0.98	1.84

Cost of Feed per Pound of Live Weight gained.

[Cents.]

Total cost, ...	–	–	9.60	7.37
Net cost, ...	–	–	3.93	3.25

* Period too short to draw any conclusions.

Remarks on the Above Figures.

It again appears that the gain in live weight about covers the net cost of the food consumed.

The comparison between corn stover and corn and soja-bean ensilage is not strictly fair, for in case of ration IV. two pounds extra of grain were fed.

Notice that, while the growth was much slower when the animals were fed corn stover, yet, because of its comparative cheapness and manurial value, the net cost of beef produced was fairly low.

Ration IV., consisting of grains and corn and soja-bean ensilage, also gave very favorable results, producing beef at a net cost of 3.25 cents per pound.

Steer No. 1.

Feeding Periods.	Feed consumed (Pounds) per Day.						Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).	Dry Matter required to produce One Pound of Live Weight (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Fodder Corn.	Serradella.	Corn Stover.	Corn and Soja-bean Ensilage.						
1892-93.												
Sept. 5 to Sept. 12,	3.00	3.00	70.00	–	–	–	27.47	1:8.7	–	–	–	–
Sept. 17 to Sept. 28,	3.00	3.00	40.00	20.00	–	–	21.67	1:6.6	–	–	–	–
Dec. 1 to Jan. 9,	3.00	3.00	–	–	11.45	–	15.28	1:8.0	1,111	1,137.5	0.66	26.5
Jan. 24 to Feb. 28,	4.00	4.00	–	–	–	43.00	16.85	1:5.8	1,180	1,255.0	2.14	7.5

	Pounds.
Live weight of animal at the beginning of the experiment,	1,111.00
Live weight of animal at the close of the experiment,	1,255.00
Live weight gained during the experiment,	144.00
Average gain in weight per day,	1.60

Steer No. 2.

FEEDING PERIODS.	Feed consumed (Pounds) per Day.						Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).	Dry Matter required to produce One Pound of Live Weight (Pounds).
	Wheat Bran.	Buffalo Gluten Feed.	Fodder Corn.	Serradella.	Corn Stover.	Corn and Soja-bean Ensilage.						
1892-93.												
Sept. 5 to Sept. 12,	3.00	3.00	70.00	–	–	–	27.47	1:8.7	–	–	–	–
Sept. 17 to Sept. 28,	3.00	3.00	40.00	20.00	–	–	21.67	1:6.6	–	–	–	–
Dec. 1 to Jan. 9,	3.00	3.00	–	–	9.64	–	13.66	1:7.5	1,055	1,117.5	1.31	10.43
Jan. 24 to Feb. 28,	3.88	3.88	–	–	–	41.00	16.41	1:5.8	1,150	1,215.0	1.55	10.60

	Pounds.
Live weight of animal at the beginning of the experiment,	1,055.00
Live weight of animal at the close of the experiment,	1,215.00
Live weight gained during the experiment,	160.00
Average gain in weight per day,	1.78

Conclusions.

In answer to question 1: *What rations are best to produce the greatest growth for the least outlay of money?*

The experiment indicates: —

a. That those coarse fodders should be grown and fed that produce the largest amount of dry matter upon a given area; leguminous crops are especially valuable as coarse fodders.

b. Such coarse foods as corn fodder, corn ensilage, corn and soja-bean ensilage, and vetch and oats take the place of hay, and when fed in combination with concentrated nitrogenous feed stuffs, as in rations given, have produced very favorable results.

c. Animals are more than machines, — they are living beings, of so complicated a nature that they are very liable to get out of order, or, not being in the proper condition, they fail to respond to the foods fed as expected. Therefore, one experiment is not in itself sufficient to enable any one to judge with certainty as to the comparative merits of different foods, but it serves rather as a link in the chain of evidence. When the experiments in this line are completed, the combined evidence will be instrumental in pointing out lessons of permanent value.

II. THE COST OF BEEF PRODUCTION.

For a considerable time the idea has been prevalent among intelligent farmers in Massachusetts that beef production could not be carried on with profit. No extended observations have been made, however, or no accurate accounts kept that would give any facts to show at what price beef could actually be produced; and in order to answer this question, experiments have been carried on at the station for several years. The following record is presented as a result of the experiment with the two steers already described. The steers were purchased Nov. 19, 1891, at $3\frac{1}{2}$ cents per pound of live weight, and sold Feb. 28, 1893, at $4\frac{1}{4}$ cents per pound of live weight. They were not put out to pasture during the summer of 1892, but were kept in the barn or turned into the yard, and were fed a variety of green crops with grains.

Steer No. 1.

Fodder Articles.	Feed consumed (Pounds).	Dry Matter (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Wheat bran,	1,403	1,262.7	$14 73	$7 71	$7 02
Chicago maize feed,	389	355.0	4 86	2 21	2 65
Buffalo gluten feed,	964	892.0	10 60	5 54	5 06
Cotton-seed meal,	56	51.0	0 78	0 55	0 23
Hay,	821	741.0	6 15	2 24	3 91
Corn fodder,	2,637	831.0	3 29	1 35	1 94
Corn stover,	1,538	1,291.9	3 84	3 22	0 62
Dent corn ensilage,	1,178	235.6	1 47	0 68	0 79
Sweet corn ensilage,	1,214	190.5	1 51	0 59	0 92
Corn and soja-bean ensilage,	2,130	472.8	2 92	1 49	1 43
Green rye,	474	179.6	0 59	0 39	0 20
Peas and oats (green),	470	64.4	0 64	0 34	0 30
Vetch and oats (green),	1,160	208.8	1 59	1 04	0 55
Serradella (green),	523	95.0	0 72	0 42	0 30
Cabbages,	636	60.4	0 79	0 39	0 40
Turnips,	460	45.2	0 57	0 21	0 36
Mangolds,	306	37.3	0 61	0 15	0 46
Sugar beets,	366	53.8	0 91	0 22	0 69
Other green crops,	427	59.9	0 53	0 26	0 27
		7,127.9	$57 10	$29 00	$28 10

	Pounds.
Live weight of animal when purchased,	588
Live weight of animal when sold,	1,255
Total gain during the experiment,	667

Financial Statement.

	Debit.	Credit.
Original cost of steer, 588 pounds at $3\frac{1}{2}$ cents, . .	$20 47	
Total cost of feed, ...	57 10	
Selling price of steer, 1,255 pounds at $4\frac{1}{4}$ cents, .		$53 34
Value of manure produced, ...		29 00
	$77 57	$82 34

Total cost of feed required to produce 1 pound of live weight,	8.55 cts.
Net cost of feed required to produce 1 pound of live weight,	4.22 "
Average gain in weight per day, ...	1.43 lbs.
Dry matter required to produce 1 pound of live weight, .	10.64 "

Steer No. 2.

Fodder Articles.	Feed consumed (Pounds).	Dry Matter (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Wheat bran, ...	1,350	1,214.5	$14 17	$7 42	$6 75
Chicago maize feed, .	389	354.0	4 86	2 21	2 65
Buffalo gluten feed, .	911	841.5	10 01	5 23	4 78
Cotton-seed meal, . .	56	51.0	0 78	0 55	0 23
Hay, ...	767	692.6	5 75	2 11	3 64
Corn fodder, . . .	2,638	831.0	3 29	1 35	1 94
Corn stover, . . .	1,342	1,127.3	3 35	2 81	0 54
Dent corn ensilage, .	1,169	233.8	1 46	0 68	0 78
Sweet corn ensilage, .	1,400	220.0	1 75	0 67	1 08
Corn and soja-bean ensilage, ...	2,041	453.1	2 80	1 43	1 37
Green rye, ...	474	179.6	0 59	0 39	0 20
Peas and oats (green), .	470	64.4	0 69	0 34	0 35
Vetch and oats (green). .	1,160	208.8	1 59	1 04	0 55
Serradella (green), .	483	86.9	0 66	0 39	0 27
Cabbages, ...	635	60.4	0 79	0 39	0 40
Turnips, ...	460	45.2	0 57	0 21	0 36
Mangolds, ...	306	37.3	0 61	0 15	0 46
Sugar beets, . . .	366	53.8	0 91	0 22	0 69
Other green crops, . .	427	59.9	0 53	0 27	0 26
		6,815.1	$55 16	$27 86	$27 30

	Pounds.
Live weight of animal when purchased, ...	595
Live weight of animal when sold, ...	1,215
Total gain during experiment, ...	620

Financial Statement.

	Debit.	Credit.
Original cost of steer, 595 pounds, at $3\frac{1}{2}$ cents, . .	$20 82	
Total cost of feed, ...	55 16	
Selling price of steer, 1,215 pounds, at $4\frac{1}{4}$ cents, .		$51 64
Value of manure produced, ...		27 57
	$75 98	$79 21

Total cost of feed required to produce 1 pound of live weight,	8.90 cts.
Net cost of feed required to produce 1 pound of live weight,	4.40 "
Average gain in weight per day, ...	1.32 lbs.
Dry matter required to produce 1 pound of live weight, .	10.99 "

Conclusions.

In answer to inquiry II. : — *The cost of beef production.*

a. The financial statement shows that, excluding the cost of labor, the coarse fodder articles and grains have been sold at market rates, and have been a trifle more than paid for in the value of the beef and of the manure produced. The value of the latter is calculated on the basis of the current market rates for nitrogen, phosphoric acid and potash.

b. Taking an average of the two steers, the total cost of producing 1 pound of live weight was 8.7 cents and the net cost $4\frac{1}{4}$ cents.

c. The average daily gain for the entire experiment (467 days) was 1.37 pounds, and the dry matter required to produce 1 pound of gain was 10.82 pounds.

d. These results are interesting, if not encouraging. The experiments are being continued, and it is hoped that in the next report the results of the work in this direction for the past four years can be presented. The results of one experiment are by no means conclusive. It is only when the average of a considerable number of experiments, in which all or nearly all give practically the same results, that the desired facts are obtained.

III. SUMMER SOILING *vs.* PASTURE.

The third object of the present steer-feeding experiment was to ascertain the relative merits of summer soiling *vs.*

pasture for growing steers. With this end in view the steers were kept in the barn during the summer or turned into the barn-yard and fed with a variety of green crops raised upon the station grounds in connection with grain. Steers 1 and 2 consumed practically the same amount of feed during this period.

Feed consumed by each Steer during Summer Soiling.

Fodder Articles.	Feed consumed (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Wheat bran, ...	454	$4 59	$2 49	$2 10
Buffalo gluten feed, . . .	454	5 04	2 87	2 17
Hay, ...	232	1 74	0 63	1 11
Corn fodder, ...	2,372	2 96	1 22	1 74
Green rye, ...	474	0 59	0 39	0 20
Peas and oats (green), . . .	470	0 69	0 33	0 36
Vetch and oats (green), . .	1,160	1 59	1 04	0 55
Serradella (green), . . .	383	0 52	0 31	0 21
Cabbages, ...	496	0 62	0 31	0 31
Sugar beets, ...	240	0 60	0 16	0 44
Other green crops, . . .	387	0 53	0 26	0 27
		$19 47	$10 01	$9 46

Summer Soiling compared with Pasture.

	Soiling.		Pasture.	
	Steer 1.	Steer 2.	Average Two Steers. **1890.**	Average Three Steers. **1891.**
Date of beginning experiment, . . .	May 1.	May 1.	May 10.	April 27.
Date of ending experiment, ...	Sept. 30.	Sept. 30.	Sept. 30.	Nov. 3.
Number of days, ...	153	153	144	190
Live weight of steers at beginning of experiment, ...	818	827	867	828
Live weight of steers at end of experiment,	1,040	1,015	971	935
Total weight gained, ...	232	188	104	107
Average gain in weight per day, . . .	1.52	1.23	0.72	0.57
Total cost of feed per day, soiling (cents),	12.72	12.72	–	–
Net cost of feed per day, soiling (cents), .	6.18	6.18	–	–
Total cost of feed per day at 40 cents per week for pasture (cents), . . .	–	–	5.71	3.57*
Total cost of feed required to produce one pound of live weight (cents), . .	8.39	10.35	8.24	6.36
Net cost of feed required to produce one pound of live weight (cents), .	4.08	5.03	–	–

* Allowing 25 cents per week for pasture.

Comments on the results of inquiry III.

The above experiment with soiling in case of growing steers is the first tried at the station. Another experiment with three steers is under way, and will be reported later.

It will be seen from the table that: —

1. The different steers gained from two to three times as much in live weight per day when fed at home as when pastured.

2. The price paid for the pasture will in a measure govern the profit and loss of the operation.

3. The total cost of the feed required to produce one pound of live weight was approximately the same in the different experiments. In case of the three steers pastured in 1891, the cost of feed per day, 6.36 cents, was less than in the case of the soiling experiment, being due to the low price paid for the pasture.

4. In case of soiling, the net cost of feed required to produce one pound of live weight, 4 to 5 cents, proved to be about one-half the total cost. In other words, the chief gain seems to have been in the value of the manure produced.

Disadvantages of Pasture.

1. The uncertainty of the supply of food, being governed (*a*) by the weather and (*b*) by the general poor condition of the New England grazing lands.

2. The loss of the manure.

3. The loss of live weight, apparently unavoidably connected with a system of changing from stall feeding to pasturing and back again. This loss has generally amounted to from 20 to 30 pounds of live weight per animal.

4. The slowness of the gain in live weight as compared with soiling.

Advantages and Disadvantages of Soiling.

1. The experiment shows that nearly three times as much gain in live weight per day has been produced by soiling as by pasturing.

2. The chief disadvantage would be in the cost of the labor required to care for the animals during this period, and the expense in growing the green crops.

3. An advantage would be found in the greatly increased amount of fodder produced on the land in a state of cultivation.

It appears from the facts thus far shown that no absolute rule can be laid down to govern all cases. The subject, however, is worthy of the serious attention of the farmers, though local conditions and circumstances will greatly affect the decision as to which system is the more suitable for the particular locality.

III.

WINTER FEEDING EXPERIMENT WITH LAMBS.

November, 1892, to March, 1893.

The experiment about to be described is the fourth in a series designed to ascertain how best to feed the various grains and coarse fodders in order to produce the greatest live weight at the lowest possible cost.

Objects of the Experiment.

The objects of this experiment were threefold : —

I. To ascertain the economy of feeding a greater *vs.* a less quantity of protein in the daily fodder rations, *i. e.*, the old question of wide *vs.* narrow rations.

II. To see if mutton could not be produced cheaper by feeding ensilage as a part substitute for rowen, *i. e.*, to get cheaper fodder rations that would prove equally effective.

III. To ascertain what it actually costs to produce a pound of live or dressed weight.

1. General Description.

Six grade Southdown wethers were purchased Nov. 9, 1892, of Mr. G. L. Henry. Each sheep was kept in a separate pen during the entire experiment.

The average weight was about 60 pounds, and they cost 6 cents per pound. The market price at this time was 5½ cents, but, as these animals had been on the road for several days without much food, the seller considered 6 cents a fair price. The sheep were kept in the stable for ten days, to get them accustomed to their surroundings, and were fed

during that time upon Buffalo gluten feed and soja-bean straw. They were sheared November 18, with the following results: —

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Weight before shearing,	60.50	65.00	66.00	74.25	69.00	67.75
Weight after shearing,	56.75	60.75	62.50	70.25	65.25	64.50
Weight of wool,	3.75	4.25	3.50	4.00	3.75	3.25

2. Fodder Articles Fed.

The grain feed consisted of Buffalo gluten feed and cotton-seed meal of good average quality and condition.

The coarse fodder consisted of a fairly good quality of rowen and an average quality of corn and soja-bean ensilage, raised and prepared upon the station grounds.

3. Local Market Cost, per Ton, of the Various Articles of Fodder used.

Buffalo gluten feed,	$21 00
Cotton-seed meal,	28 00
Rowen,	15 00
Corn and soja-bean ensilage,	2 75

4. Mode of Feeding.

The animals were fed twice each day, about eight o'clock in the morning and at five in the afternoon, one-half the feed being given at each time. Water was offered *ad libitum*. About five grammes ($\frac{1}{6}$ ounce) of salt were fed daily, mixed with the grain.

I. TO ASCERTAIN THE ECONOMY OF FEEDING A GREATER *vs.* A LESS QUANTITY OF PROTEIN IN THE DAILY FODDER RATIONS.

The animals were divided into two lots of three each, each sheep, as before stated, being kept in a separate pen.

Lot I., consisting of sheep No. 1, No. 2 and No. 3, was fed a ration having a nutritive ratio of 1 : 4.5 during the entire experiment, which began Nov. 19, 1892, and closed March 13, 1893.

Lot II., consisting of sheep No. 4, No. 5 and No. 6, was fed a ration of 1 : 5.5 from Nov. 19, 1892, till Feb. 15, 1893,

when the ratio was changed to 1 : 4.5, and so continued till March 13, 1893.

Both lots received approximately the same amount of digestible organic matter.

Analyses of the Various Articles of Fodder used.

Fodder Analyses.	Buffalo Gluten Feed.	Cotton-seed Meal	Rowen.	Corn and Soja-bean Ensilage.
Moisture at 100° C.,	7.18	6.20	11.30	77.77
Dry matter,	92.82	93.80	88.70	22.23
	100.00	100.00	100.00	100.00
Analysis of Dry Matter.				
Crude ash,	0.84	7.37	6.48	9.48
" cellulose,	7.50	5.81	29.98	26.63
" fat,	12.75	13.04	4.23	3.75
" protein,	26.28	44.71	12.11	7.91
Non-nitrogenous extract matter,	52.63	28.57	47.20	52.23
	100.00	100.00	100 00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

Fertilizer Analyses.	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.
Moisture,	7.18	6.20	11.30	77.77
Nitrogen,	4.25	7.15	1.94	0.32
Phosphoric acid,	0.30	2.33	0.46	0.12
Potassium oxide,	0.04	1.72	1.97	0.48
Valuation per 2,000 pounds,	$13 13	$25 56	$8 10	$1 52
Manurial value obtainable,	12 07	23 57	7 45	1 40

Average Composition of the Daily Fodder Rations used during the Successive Feeding Periods.

Lot I.

I.		II.	
November 19 to November 30.		*December 1 to January 9.*	
Buffalo gluten feed,	0.62 lbs.	Buffalo gluten feed,	0.87 lbs.
Cotton-seed meal,	0.12 "	Cotton-seed meal,	0 20 "
Rowen,	1.25 "	Rowen,	1.75 "
Nutritive ratio,	1 : 4.5	Nutritive ratio,	1 : 4 6
Total cost,	1.76 cts.	Total cost,	2.50 cts.
Manurial value obtainable,	0.97 "	Manurial value obtainable,	1.39 "
Net cost,	0.79 "	Net cost,	1.11 "

III.	
January 24 to March 17	
Buffalo gluten feed,	0.87 lbs.
Cotton-seed meal,	0.20 "
Rowen,	0.50 "
Corn and soja-bean ensilage,	3.00 "
Nutritive ratio,	1 : 4.7
Total cost,	1.97 cts.
Manurial value obtainable,	1.15 "
Net cost,	0.82 "

Lot II.

I.		II.	
November 19 to November 30.		*December 1 to January 9.*	
Buffalo gluten feed,	0.50 lbs.	Buffalo gluten feed,	0.62 lbs.
Rowen,	1.75 "	Rowen,	2.00 "
Nutritive ratio,	1 : 5.5	Nutritive ratio,	1 : 5.5
Total cost,	1.81 cts.	Total cost,	2.15 cts.
Manurial value obtainable,	0.95 "	Manurial value obtainable,	1.11 "
Net cost,	0.86 "	Net cost,	1.04 "

III.		IV.	
January 24 to February 15.		*February 20 to March 7.*	
Buffalo gluten feed,	0.62 lbs.	Buffalo gluten feed,	0 90 lbs.
Cotton-seed meal,	0.12 "	Cotton-seed meal,	0.20 "
Rowen,	0.50 "	Rowen,	0.50 "
Corn and soja-bean ensilage,	4.50 "	Corn and soja-bean ensilage,	3.00 "
Nutritive ratio,	1 : 5.7	Nutritive ratio,	1 : 4.7
Total cost,	1.78 cts.	Total cost,	1.97 cts.
Manurial value obtainable,	1.01 "	Manurial value obtainable,	1.15 "
Net cost,	0.77 "	Net cost,	0.82 "

Digestible Matter in the Above Rations.

[Ounces.]

	Feeding Periods.						
	Lot I.			Lot II.			
	I.	II.	III.	I.	II.	III.	IV.
Protein,	–	5.40	4.66	–	4.16	3.82	4.66
Fat,	–	2.05	2.18	–	1.48	1.86	2.18
Carbo-hydrates,	–	19.91	16.49	–	19.08	17.00	16.49
Total,	–	27.36	23.33	–	24.72	22.68	23.33

It will be noticed that Lot I. was fed with one exception more protein than Lot II., thus giving the narrow ration. The total amount of digestible organic matter, however, remained essentially the same during each parallel period. During the second feeding period both lots consumed more feed daily than at any other time.

Summary of Cost of the Above-stated Average Daily Fodder Rations.

[Cents.]

	Feeding Periods.						
	Lot I.			Lot II.			
	I.	II.	III.	I.	II.	III.	IV.
Total cost,	1.76	2.50	1.97	1.81	2.15	1.78	1.97
Manurial value obtainable,*	0.97	1.39	1.10	0.95	1.11	1.01	1.15
Net cost,	0.79	1.11	0.87	0.86	1.04	0.77	0.82

* Allowing ninety-two per cent. of the fertilizing ingredients of the feed to be recovered in the manure.

Comparisons of Lot I. (Ratio 1 : 4.5) with Lot II. (Ratio 1 : 5.5).

	Lot I.	Lot II.
	Weight.	Weight.
Beginning of experiment, November 19,	180.0 lbs.	200.0 lbs.
Close of experiment, February 14,	252.5 "	267.0 "
Gain during experiment,	72.5 "	67.0* "

The next step would be to inquire into the cost of feed consumed by Lots I. and II., thus ascertaining the cost per pound of live weight gained.

	Lot I.				Lot II.			
	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.
Feed consumed (pounds),	214.40	44.00	303.25	236.00	165.30	9.37	345.25	364.75
Total cost,	$2 25	$0 62	$2 27	$0 32	$1 74	$0 13	$2 59	$0 50
Manurial value obtainable,	1 29	0 52	1 12	0 17	0 99	0 11	1 28	0 26
Net cost,	0 96	0 10	1 15	0 15	0 75	0 02	1 31	0 24

	Lot I.	Lot II.
Live weight gained during experiment,	72.5 lbs.	67.0 lbs.
Total cost of feed,	$5 46	$4 96
Net cost of feed,	2 36	2 32
Total cost of feed per pound of live weight gained,	7.53 cts.	7.42 cts.
Net cost of feed per pound of live weight gained,	3.25 "	3.48 "

* Sheep No. 6, in Lot II., suffered from a severe cold during practically the entire month of December, and, consequently, did not eat as well nor gain as rapidly as the other two in this lot. Had No. 6 made the same average growth as sheep No. 4 and No. 5, the gain in live weight in Lots I. and II. would have been practically identical.

Summary.

Lot I., narrow ration, 1 : 4.5.

Lot II., wider ration, 1 : 5.5.

Length of experiment, 88 days.

In answer to question I. viz., the economy of feeding rations with a nutritive ratio of 1 : 5.5 *vs.* one with a nutritive ratio of 1 : 4.5, the experiment gives the following: —

1. The gain in live weight is somewhat in favor of Lot I., to which more protein was fed.

2. The total cost of producing one pound of live weight with Lot I. was 7.53 cents and with Lot II. 7.42 cents, while the net cost with Lot I. was 3.25 cents, a little lower than with Lot II., which was 3.48 cents.

3. The results of the experiment are practically identical in case of both lots. Had sheep No. 6 been in good health during December, and made the same relative gain as No. 4 and No. 5, the results would have been rather in favor of Lot II.

4. Sheep Nos. 4 and 5 were not slaughtered. Sheep No. 3 was the fattest, No. 6 next, then came No. 1 and lastly No. 2. These results give no positive information, but would indicate in this case that the constitutional tendency of the animal, rather than the feed consumed, governed the amount of fat and flesh produced.

The Situation Briefly Stated.

This experiment would indicate, and it is borne out by the majority of other experiments made with reference to this point, that for the production of lean and fat in case of growing animals a ratio of 1 : 5 to 1 : 5.5 is about as economical a one as can be fed.

In order to get more definite light upon this matter, one must await the results of the carefully conducted experiments with the so-called respiration apparatus now in progress, or a large number of animals must be experimented with, and the average results taken.

It is certainly true that the constitution of the animal, no less than the quantity and proportion in which the different food components are fed, exerts a decided influence upon the production of both lean meat and fat. Experiments, there-

fore, after the manner of the one previously described, must be conducted with a large number of sheep, in order to eliminate as far as possible this source of error, and furnish data that will throw more definite light upon the subject. It is held by many who have good grounds upon which to base their belief that rations with a ratio of 1 : 4 can be economically fed.

OBJECT II. TO SEE IF LIVE WEIGHT COULD NOT BE PRODUCED CHEAPER BY SUBSTITUTING CORN AND SOJA-BEAN ENSILAGE TO A CONSIDERABLE EXTENT FOR ROWEN.

Feeding Period I. The six sheep used in the experiment were fed for seven weeks upon Buffalo gluten feed, cotton-seed meal and rowen.

Feeding Period II. In this period corn and soja-bean ensilage was substituted for the larger part of the rowen.

The following table gives the amounts of the several foods consumed and the total and net cost of the same, as well as the total and net cost of feed required to produce one pound of live weight.

	Feeding Period I.				Feeding Period II.				
	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Dry Matter.	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.	Dry Matter.
Feed consumed (pounds),	204.25	24.75	497.50	653.74	245.25	54.56	150.00	826.50	595.00
Total cost, ...	$2 14	$0 35	$3 75	-	$2 57	$0 76	$1 12	$1 13	-
Manurial value obtainable,	1 22	0 29	1 84	-	1 47	0 64	0 55	0 58	-
Net cost, ...	0 92	0 06	1 91	-	1 10	0 12	0 57	0 55	-

	Feeding Period I.	Feeding Period II.
Weight at the beginning of the experiment, .	380.00 lbs.	485.75 lbs.
Weight at the end of the experiment, . .	461.50 "	565.00 "
Gain in weight during experiment, . .	81.50 "	79.25 "
Total cost of feed, ...	$6 26	$5 58
Net cost of feed, ...	2 89	2 34
Total cost of feed per pound of live weight gained, ...	7.68 cts.	7.04 cts.
Net cost of feed per pound of live weight gained, ...	3.55 "	2.95 "
Dry matter required to produce 1 pound of live weight, ...	8.00 "	7.51 "

Answer to Object II.

The result of the experiment is in favor of the corn and soja-bean ensilage as a substitute for a larger part of the rowen.

The total and net cost of feed required to produce one pound of live weight in Feeding Period I. was 7.68 cents and 3.55 cents, while in Feeding Period II. it was but 7.04 cents and 2.95 cents.

The dry matter required to produce one pound of live weight was also somewhat less in Feeding Period II. This answer coincides with many other experiments made at this station, and shows that in order to produce beef or mutton at the lowest cost cheap fodders must be fed in place of costly hay. Well-made corn ensilage proves a very excellent and economical substitute.

OBJECT III. TO ASCERTAIN, IN THE CASE OF GROWING LAMBS, WHAT IT COSTS TO PRODUCE ONE POUND OF LIVE OR DRESSED WEIGHT.

While this question has been in a measure answered under II., still, it is well to make a complete financial statement of the experiment. The feeding experiment proper began on Nov. 19, 1892. The sheep were sheared on the day previous. They were fed till March 13, 1893, upon which date they were again sheared, and sold at 11 cents per pound of dressed weight.

Live Weight gained during the Experiment (115 Days).

[Pounds.]

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Beginning of experiment, .	56.75	60.75	62.50	70.25	65.25	64.50
End of experiment, . .	95.50	87.75	93.50	102.00	96.50	89.75
Gain during experiment, .	38.75	27.00	31.00	31.75	31.25	25.25

Yield of Wool and Dressed Weight.

[Pounds.]

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Yield of wool at beginning of experiment, . . .	3.75	4.25	3.50	4.00	3.75	3.25
Yield of wool during experiment (115 days), . .	3.00	3.00	2.13	–*	–*	2.75
Yield of dressed weight, .	48.50	43.75	48.25	–	–	45.25

* Retained for further experiments.

Feed consumed.

	Total Cost.	Manurial Value Obtainable.	Net Cost.
525.0 pounds Buffalo gluten feed, . .	$5 51	$3 15	$2 36
87.3 pounds cotton-seed meal, . .	1 22	1 02	0 20
730.0 pounds rowen, ...	5 47	2 70	2 77
1,449.0 pounds corn and soja-bean ensilage,	1 99	1 01	0 98
	$14 19	$7 88	$6 31

Average Results.

Total weight at the beginning of the experiment (sheared),	380.00 lbs.
Total weight at the end of the experiment, ...	565.00 "
Total gain in live weight, ...	185.00 "
Average gain per sheep in live weight per day (115 days), .	0.27 "
Average shrinkage (four sheep) in dressing, . . .	49.32 "
Total cost of feed per pound of live weight gained, . .	7.67 cts.
Total cost of feed per pound of dressed weight gained, .	15.13 "
Net cost of feed per pound of live weight gained, . .	3.41 "
Net cost of feed per pound of dressed weight gained, . .	6.70 "

Financial Statement.

	Debit.	Credit.
402.50 pounds live weight, at $5\frac{1}{2}$ cents, . .	$22 14	–
Cost of feed, ...	14 19	–
283.60 * pounds dressed weight, at 11 cents, .	–	$31 20
39.38 pounds of wool, at 21 cents, . . .	–	8 27
Value of manure produced, ...	–	7 68
	$36 33	$47 15
Balance in favor of credit, ...	$10 82	–

* Assuming that Nos. 4 and 5 would shrink the same amount in dressing as Nos. 1, 2, 3 and 6.

Answer to Object III.

The results show (*a*) that the average total cost of feed required to produce one pound of live weight, on the retail price of coarse fodders and grains, as previously stated, was 7.67 cents, and the net cost 3.41 cents; the total cost per pound of dressed weight was 15.13 cents and the net cost 6.94 cents.

(*b*) The profit and loss account shows that the financial advantages of feeding yearlings during the winter are to be found, first, in selling the coarse fodder articles at a fair retail price; and, second, in the value of the manure produced. It also makes this fact very emphatic, viz., that the manure, solid as well as liquid, should be carefully guarded from any loss. The manure is valuable chiefly for the nitrogen, phosphoric acid and potash it contains, as these ingredients cost respectively 15 cents, $5\frac{1}{2}$ cents and $4\frac{1}{2}$ cents per pound in the markets. The manure, reckoned on this basis, has been found to be equal to one-half the cost of the feed consumed.

Detailed Record of Each Sheep.

Sheep No. 1.

Feeding Periods.	Feed consumed (Pounds) per Day.				Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Total Gain in Live Weight (Pounds).
	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.					
1892-93.									
Nov. 19 to Jan. 10, .	0.79	0.16	1.53	–	2.24	1:4.5	0.375	5.97	19.50
Jan. 24 to March 14,	0.87	0.20	0.50	2.81	2.06	1:4.6	0.224	9.22	10.95

Total Amount of Feed consumed from Nov. 19, 1892, to March 14, 1893.

	Dry Matter.	Total Cost.	Manurial Value Obtainable.	Net Cost.
94.48 pounds Buffalo gluten feed, .	87.68	$0 99	$0 56	$0 43
20.02 pounds cotton-seed meal, .	18.77	0 28	0 23	0 05
112.56 pounds rowen, . . .	99.84	0 84	0 36	0 48
171.69 pounds corn and soja-bean ensilage, ...	39.17	0 23	0 10	0 13
	245.46	$2 34	$1 25	$1 09

Live weight of animal at the beginning of the experiment,	56.75	lbs.
Live weight of animal at the end of the experiment, . .	92.50	"
Live weight gained during the experiment, . . .	35.75	"
Average gain in weight per day, ...	0.31	"
Dressed weight of animal, ...	48.50	"
Loss in weight by dressing, 47.56 per cent., . . .	44.00	"
Pounds of dry matter fed produced 1 pound of live weight,	6.86 *	"
Total cost of feed per pound of live weight gained, . .	6.54	cts.
Net cost of feed per pound of live weight gained, . .	3.05	"

* Exclusive of wool.

Sheep No. 2.

Feeding Periods.	Feed consumed (Pounds) per Day. Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.	Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Total Gain in Live Weight (Pounds).
1892-93.									
Nov. 19 to Jan. 10, .	0.78	0.16	1.57	–	2.26	1:4.5	0.279	8.10	14.50
Jan. 24 to March 14,	0.87	0.20	0.50	2.13	1.91	1:4.4	0.189	10.12	9.25

Total Amount of Feed consumed from Nov. 19, 1892, to March 14, 1893.

	Dry Matter.	Total Cost.	Manurial Value Obtainable.	Net Cost.
93.44 pounds Buffalo gluten feed,	86.73	$0 99	$0 56	$0 43
20.06 pounds cotton-seed meal, .	18.77	0 28	0 22	0 06
114.64 pounds rowen, . . .	100.68	0 86	0 37	0 49
135.62 pounds corn and soja-bean ensilage, ...	30.15	0 19	0 08	0 11
	236.33	$2 32	$1 23	$1 09

Live weight of animal at the beginning of the experiment,	60.75 lbs.
Live weight of animal at the end of the experiment, . . .	84.75 "
Live weight gained during the experiment, ...	24.00 "
Average gain in weight per day, ...	0.21 "
Dressed weight of animal, ...	43.75 "
Loss in weight by dressing, 48.37 per cent., ...	41.00 "
Pounds of dry matter fed produced 1 pound of live weight, .	9.84 "
Total cost of feed per pound of live weight gained, . . .	9.66 cts.
Net cost of feed per pound of live weight gained, . . .	4.54 "

Sheep No. 3.

Feeding Periods.	Feed consumed (Pounds) per Day. Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.	Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Total Gain in Live Weight (Pounds).
1892-93.									
Nov. 19 to Jan. 10, .	0.81	0.16	1.51	–	2.25	1:4.5	0.317	7.09	16.50
Jan. 24 to March 14,	0.87	0.20	0.50	2.68	2.03	1:4.5	0.214	9.47	10.50

Total Amount of Feed consumed from Nov. 19, 1892, to March 14, 1893.

	Dry Matter.	Total Cost.	Manurial Value Obtainable.	Net Cost.
95.00 pounds Buffalo gluten feed, .	87.17	$0 99	$0 56	$0 43
20.54 pounds cotton-seed meal, .	19.26	0 29	0 24	0 05
111.52 pounds rowen, ...	98.92	0 83	0 36	0 47
164.22 pounds corn and soja-bean ensilage, ...	36.50	0 22	0 10	0 12
	241.85	$2 33	$1 26	$1 07

Live weight of animal at the beginning of the experiment, .	62.50	lbs.
Live weight of animal at the end of the experiment, . .	91.50	"
Live weight gained during the experiment, ...	29.00	"
Average gain in weight per day, ...	0.25	"
Dressed weight of animal, ...	48.25	"
Loss in weight by dressing, 47.26 per cent., ...	43.25	"
Pounds of dry matter fed produced 1 pound of live weight, .	8.54	"
Total cost of feed per pound of live weight gained, . .	8.03	cts.
Net cost of feed per pound of live weight gained, . . .	3.70	"

Sheep No. 4.

Feeding Periods.	Feed consumed (Pounds) per Day. Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.	Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Total Gain in Live Weight (Pounds).
1892-93.									
Nov. 19 to Jan. 10, .	0.60	–	1.88	–	2.22	1:5.5	0.298	7.45	15.50
Jan. 24 to Feb. 15, .	0.534	0.125	0.50	3.79	1.90	1:5.6	0.250	7.60	5.50
Feb. 15 to March 14,	0.875	0.20	0.50	2.96	2.10	1:4.7	0.324	6.93	8.75

Total Amount of Feed consumed from Nov. 19, 1892, to March 14, 1893.

	Dry Matter.	Total Cost.	Manurial Value Obtainable.	Net Cost.
76.07 pounds Buffalo gluten feed, .	70.60	$0 79	$0 46	$0 33
8.52 pounds cotton-seed meal, .	7.98	0 11	0 09	0 02
129.76 pounds rowen, . . .	115.10	0 97	0 41	0 56
211.80 pounds corn and soja-bean ensilage, ...	47.08	0 30	0 12	0 18
	247.76	$2 17	$1 08	$1 09

Live weight of animal at the beginning of the experiment, . 70.25 lbs.
Live weight of animal at the end of the experiment, . . 99.00 "
Live weight gained during the experiment, ... 28.75 "
Average gain in weight per day, ... 0.25 "
Dressed weight of animal, ... –
Loss in weight by dressing, ... –
Pounds of dry matter fed produced 1 pound of live weight, . 8.37 "
Total cost of feed per pound of live weight gained, . . 7.54 cts.
Net cost of feed per pound of live weight gained, . . 3.78 "

Sheep No. 5.

Feeding Periods.	Feed consumed (Pounds) per Day.				Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Total Gain in Live Weight (Pounds).
	Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.					
1892-93.									
Nov. 19 to Jan. 10, .	0.60	–	1.96	–	2.29	1:5.5	0.332	6.90	17.25
Jan. 24 to Feb. 15, .	0.534	0.125	0.50	3.48	1.83	1:5.5	0.318	5.75	7.00
Feb. 15 to March 14,	0.875	0.20	0.50	2.55	2.01	1:4.6	0.213	9.44	5.75

Total Amount of Feed consumed from Nov. 19, 1892, to March 14, 1893.

	Dry Matter.	Total Cost.	Manurial Value Obtainable.	Net Cost.
76.07 pounds Buffalo gluten feed, .	70.60	$0 80	$0 45	$0 35
8.52 pounds cotton-seed meal, .	7.98	0 11	0 09	0 02
133.92 pounds rowen, ...	118.79	1 00	0 42	0 58
211.66 pounds corn and soja-bean ensilage, ...	47.05	0 29	0 73	0 16
	244.42	$2 20	$1 09	$1 11

Live weight of animal at the beginning of the experiment, . 65.25 lbs.
Live weight of animal at the end of the experiment, . . 93.50 "
Live weight gained during the experiment, ... 28.25 "
Average gain in weight per day, ... 0.25 "
Dressed weight of animal, ... –
Loss in weight by dressing, ... –
Pounds of dry matter fed produced 1 pound of live weight, . 8.65 "
Total cost of feed per pound of live weight gained, . . 7.78 cts.
Net cost of feed per pound of live weight gained, . . . 3.93 "

Sheep No. 6.

Feeding Periods.	Feed consumed (Pounds) per Day. Buffalo Gluten Feed.	Cotton-seed Meal.	Rowen.	Corn and Soja-bean Ensilage.	Dry Matter consumed per Day (Pounds).	Nutritive Ratio.	Gain in Weight per Day (Pounds).	Pounds of Dry Matter produced One Pound Live Weight.	Total Gain in Live Weight (Pounds).
1892-93.									
Nov. 19 to Jan. 10, .	0.57	–	1.68	–	2.01	1:5.4	0.202	9.95	10.50
Jan. 24 to Feb. 15, .	0.534	0.125	0.50	3.83	1.90	1:5.6	0.193	9.83	4.25
Feb. 15 to March 24,	0.875	0.20	0.50	2.61	2.02	1:4.6	0.148	13.63	4.00

Total Amount of Feed consumed from Nov. 19, 1892, to March 14, 1893.

	Dry Matter.	Total Cost.	Manurial Value Obtainable.	Net Cost.
74.51 pounds Buffalo gluten feed, .	69.14	$0 78	$0 45	$0 33
8.52 pounds cotton-seed meal, .	7.98	0 11	0 09	0 02
119.36 pounds rowen, . . .	104.88	0 90	0 38	0 52
198.23 pounds corn and soja-bean ensilage, ...	45.39	0 28	0 12	0 16
	227.39	$2 07	$1 04	$1 03

Live weight of animal at the beginning of the experiment,	64.50 lbs.
Live weight of animal at the end of the experiment, . .	87.00 "
Live weight gained during the experiment, ...	22.50 "
Average gain in weight per day, ...	0.195 "
Dressed weight of animal, ...	45.25 "
Loss in weight by dressing, 47.93 per cent., ...	41.75 "
Pounds of dry matter fed produced 1 pound of live weight, .	10.11 "
Total cost of feed per pound of live weight gained, . .	9.20 cts.
Net cost of feed per pound of live weight gained, . .	4.58 "

GENERAL SUMMARY OF FEEDING EXPERIMENTS WITH GROWING LAMBS.

1890–93.

A series of winter feeding experiments has been carried on at the station during the past four years, 1890–93, with lambs born the previous spring.

Many spring lambs are not far enough advanced to be sold during the late summer at good prices, and are therefore fed during the fall and winter and placed in the market in the early spring.

These experiments have sought, among other things, to ascertain: —

I. (1) The average cost of feed to produce a pound of live weight.

(2) The average daily gain in live weight.

(3) The loss of weight in dressing.

(4) The dry matter required to produce a pound of live weight.

II. The effect of wide *vs.* narrow fodder rations on the gain in weight.

III. The combinations of grains and coarse fodder articles best suited to the economical production of lambs for the market.

Eighteen sheep were used in the three experiments presented. The experiment conducted in 1892 is excluded, from the fact that the results are so different from those of the other three years. The time occupied by the different experiments varied from 120 to 200 days.

The object here is simply to present a very brief *résumé* of the results, referring the reader to the respective annual reports for details.

1. *Cost of Production.*

[Cents.]

	1890.	1891.	1893.	Average.
Total cost of feed to produce one pound live weight,	12.25	11.03	7.67	10.32
Net cost of feed to produce one pound live weight,	6.19	6.31	3.41	5.30

2. *Average Gain.*

[Pounds.]

Average daily gain in live weight,	0.19	0.21	0.27	0.22

3. *Shrinkage.*

[Per Cent.]

Loss in weight by dressing,	45.3	49.9	49.3	48.2

4. *Dry Matter.*

[Pounds.]

Dry matter required to produce one pound live weight,	13.61	10.04	7.75	10.47

II. Wide *vs.* narrow rations. During the years 1890 and 1891 the effect of feeding wide and narrow rations was tried. The wide rations contained less protein and more carbohydrates than the narrow ones.

The wide rations had a nutritive ratio of 1 : 6.84 and the narrow rations of 1 : 4.71.

The six sheep were divided into two lots of three each.

	Nutritive Ratio.	Average Gain in Live Weight per Day (Pounds).	Total Cost of Feed per Pound Live Weight gained (Cents).	Net Cost of Feed per Pound Live Weight gained (Cents).	Dry Matter required to produce One Pound Live Weight (Pounds).
Lot I., narrow ration,	1 : 4.71	0.22	11.30	5.51	11.35
Lot II., wide ration,	1 : 6.84	0.18	11.26	6.49	11.40

The cost of production of live weight is the same in each case. The narrow rations give a better quality of manure, and cause a somewhat increased growth.

III. *Winter Fodder Rations for Growing Lambs (60 to 100 Pounds).*

The following combinations of grains and coarse fodder have proved valuable as winter fodder rations for lambs (yearlings).

In general, where corn ensilage has been substituted for one-half to two-thirds of the rowen the growth has been fully as good and the cost of production of live weight somewhat less.

I.		II.	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Chicago gluten meal,	0.50 "	Chicago gluten meal,	0.50 "
Rowen,	2.00 "	Rowen,	1.00 "
Nutritive ratio,	1 : 4.50	Corn ensilage,	3.50 "
Total cost (approximate),	2.50 cts.	Nutritive ratio,	1 : 5.09
Manurial value obtainable,	1.15 "	Total cost (approximate),	2 24 cts.
Net cost,	1.36 "	Manurial value obtainable,	1.10 "
		Net cost,	1.14 "
III.		**IV.**	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Linseed meal,	0.25 "	Linseed meal,	0 25 "
Rowen,	1.50 "	Rowen,	0.50 "
Nutritive ratio,	1 : 4 0	Corn ensilage,	3.50 "
Total cost (approximate),	2.08 cts.	Nutritive ratio,	1 : 5.0
Manurial value obtainable,	1.02 "	Total cost (approximate),	1.8 cts.
Net cost,	1.06 "	Manurial value obtainable,	0.9 "
		Net cost,	0.9 "
V.		**VI.**	
Corn meal,	0.50 lbs.	Buffalo gluten feed,	0 75 lbs.
Cotton-seed meal,	0.50 "	Rowen,	2.00 "
Rowen,	1.50 "	Nutritive ratio,	1 : 5.3
Nutritive ratio,	1 : 5.3	Total cost (approximate),	2.33 cts.
Total cost (approximate),	2 40 cts.	Manurial value obtainable,	1.25 "
Manurial value obtainable,	1 30 "	Net cost,	1.07 "
Net cost,	1.10 "		

VII.	
Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0.25 "
Rowen,	0.50 "
Corn ensilage,	4.00 "
Nutritive ratio,	1 : 4.6
Total cost (approximate),	2.04 cts.
Manurial value obtainable,	1.14 "
Net cost,	0.90 "

Remarks on Above Rations.

Linseed meal, cotton-seed meal and Chicago gluten meal can be substituted one for the other without very materially changing the cost of the ration or its feeding effect. Buffalo gluten feed and Chicago maize feed can also be used interchangeably.

One-half pound of rowen and four to five pounds of corn ensilage in a ration tends to cheapen the cost and is as effective in feeding value as one and one-half to two pounds of rowen. In general, four pounds of corn ensilage can be reckoned an equivalent for one pound of rowen, so far as dry matter is concerned.

The rations as given can be increased or decreased proportionately in quantity to suit the appetite and size of the animals fed.

General Conclusions.

The results of the three experiments during the years 1890, 1891 and 1893 with growing lambs have shown: —

1. That the average total cost of feed required to produce one pound of live weight was 10.32 cents and the net cost 5.34 cents. The selling price of live weight during these years was 6 cents per pound.

The same facts seem to hold good with sheep as with steers, viz., the coarse fodders and grains can be sold at market rates and paid for in the value of the live weight produced, and in the value of the nitrogen, phosphoric acid and potash in the manure at the current market prices for these articles.

This experiment and many others made at the station make the following point very emphatic: since the manure produced, both solid and liquid, figures so prominently in the financial results, it is extremely important that it should be carefully preserved.

2. Narrow rations, 1 : 4.7 (with a larger amount of digestible protein than the wide rations), have produced a greater gain in live weight than wide rations, 1 : 7.0.

3. The total cost of feed required to produce one pound of live weight was about the same in each case, namely, 11.30

cents and 11.26 cents per day. The net cost in case of narrow rations was 5.51 cents per day, against 6.49 cents per day for wider rations. This shows that the chief advantage of the very narrow rations in these experiments came from the increased value of the manure produced.

4. The dry matter required to produce one pound of live weight was about the same in both cases, namely, 11.35 and 11.40 pounds. With the present knowledge of animal nutrition, rations with a nutritive ratio of about 1 : 5 appear to be the most economical to feed to growing lambs, as well as to steers.

IV.

FEEDING EXPERIMENTS WITH PIGS (TWO).

Eighteenth Experiment.

The following experiment is a continuation of those described in previous reports of the station. In our experiments with milch cows we have had considerable quantities of skim-milk remaining after the removal of the cream, and the question has ever been as to how this milk shall be disposed of *to the best advantage.* This question is one that confronts many of the farmers of our State, from the fact that the creamery system is so generally introduced. Some farmers living near large towns have opportunity to dispose of this milk at from one to two cents per quart, and it is undoubtedly more profitable to thus dispose of it than to feed it to our farm animals. Still, to by far the larger number of farmers this opportunity does not present itself, and the milk must be utilized upon the farm by feeding it to pigs or other animals.

Object of This Experiment.

The results of our previous experiments have shown that the various grains, such as corn meal, wheat bran, gluten meal and maize feed, when fed in connection with skim-milk, have furnished very excellent and profitable rations for growing young pigs for the market. The object of this experiment has been, among other things, to learn the value of Buffalo gluten feed and corn meal when fed in connection with skim-milk for the economical production of pork for the market.

The skim-milk being a very nitrogenous article of food, with a nutritive ratio of 1 to 2.15, the rations furnished the

pigs were what might be termed narrow, varying from 1 : 3.3 to 1 : 5. Whether a narrow or a wide ration is better for growing and fattening pigs is still a matter of some dispute among investigators. It is certain, however, that the rations fed in our various experiments with pigs have been productive of most excellent results, and we can commend them to the serious attention of the farmers of the State.

Description of the Experiment.

Six grade Chester White pigs, three sows and three barrows, weighing from 25 to 30 pounds each, served us for the experiment. They were kept in separate pens, and fed three times per day, namely, in the morning at six o'clock, at noon, and in the afternoon at five o'clock, with all the food they would eat up clean. It was always our object to supply them plentifully, but at the same time not to glut them, and thus in a measure destroy their appetites.

The liquid food consisted of from three to six quarts of skim-milk per day, depending upon the size of the pigs and the quantity of milk at our disposal. It never exceeded six quarts per day. The grain fed was corn meal and Buffalo gluten feed. The gluten feed, being quite rich in protein, served to keep our rations within the limits desired when the supply of skim-milk failed, and four ounces of gluten feed was in a general way reckoned equal to one quart of skim-milk.

Number of Feeding Periods.

The experiment was divided into three distinct feeding periods. The first period continued till the pigs reached 80 pounds in weight, and the food consisted of two ounces of corn meal to every quart of milk, with a ratio of 1 : 3.3. As our supply of milk at this season was rather limited, four ounces of gluten feed was substituted for each quart of milk, and this gradually increased the ratio to 1 : 4.

The second period began when the pigs reached about 80 pounds in weight and continued till 125 pounds weight was reached. The food consisted of the skim-milk at our disposal, which varied somewhat, together with corn meal and Buffalo gluten feed, to give the desired ratio of 1 : 4.5.

The third and last period began when the pigs weighed 125 pounds and ended when 180 pounds was reached, at which time they were slaughtered. The feed consisted of skim-milk, and of a mixture of one and one-half parts corn meal and one part Buffalo gluten feed, fed in sufficient quantities to satisfy the appetite of the animals.

The following tables will, we believe, present sufficient data to enable the reader to understand the experiment and grasp the results obtained: —

Feeding Periods.	Composition of Ration.	Duration of Period.	Nutritive Ratio.
Period I., .	2 ounces corn meal to each quart milk, . .	20 to 80 pounds live weight.	1:3.3
Period II., .	4 ounces corn meal to each quart milk, and 4 ounces Buffalo gluten feed as a substitute for quart milk.	80 to 125 pounds live weight.	1:4.5
Period III.,	4 to 6 quarts milk and $1\frac{1}{2}$ parts corn meal to 1 part Buffalo gluten feed to satisfy animal.	125 to 180 pounds live weight.	1:4.9

		Average Daily Rations.					
		Skim-milk (Quarts).	Corn Meal (Ounces).	Gluten Feed (Ounces).	Nutritive Ratio.	Average Weekly Weight (Pounds).	Average Daily Gain (Pounds).
Aug. 9 to Aug. 16, . . .	Feeding Period I.	3	6	–	1:3.3	27-31.2	.59
Aug. 16 to Aug. 23, . . .		4	8	–		36.5	.76
Aug. 23 to Aug. 30, . . .		5	10	–		43.9	1.05
Aug. 30 to Sept. 6, . . .		6	12	–		49.5	.80
Sept. 6 to Sept. 13, . . .		6	12	–		56.1	.94
Sept. 13 to Sept. 20, . . .		5	12	4		63.0	.99
Sept. 20 to Sept. 27, . . .		5	14	8		71.6	1.23
Sept. 27 to Oct. 4, . . .		5	16	12		80.3	1.24
Oct. 4 to Oct. 11, . . .	Feeding Period II.	5	28	8	1:4.5	89.0	1.24
Oct. 11 to Oct. 18, . . .		5	32	12		101.7	1.81
Oct. 18 to Oct. 25, . . .		5	36	16		112.7	1.56
Oct. 25 to Nov. 1, . . .		5	36	24		126.0	1.90
Nov. 1 to Nov. 8, . . .	Feeding Period III.	4	48	28	1:4.9	143.0	2.40
Nov. 8 to Nov. 15, . . .		4	54	36		151.7	2.40
Nov. 15 to Nov. 22, . . .		4	54	40		175.2	2.20
Nov. 22 to Nov. 28, . . .		4	48	30		182.8	1.08

We now wish to call attention to a summary of the results obtained: —

Summary of Results.	Average Results of Six Pigs (Pounds).
Live weight,	182.8
Dressed weight,	144.6
Per cent of loss in dressing,	21.6
Live weight gained during experiment,	155.6
Dressed weight gained during experiment,	122.0
Dry matter required to produce 1 pound live weight,	2.27
Dry matter required to produce 1 pound dressed weight,	2.91

Financial Statement.

732.15 pounds dressed pork actually produced during the experiment, at $7\frac{1}{4}$ cents per pound,	$53 07
Cost of food required,	33 94
Profit from pork actually produced,	$19 13
Value of manure produced,	9 61
Total profit from six pigs,	$28 74
Total profit per pig,	4 79

If we take into consideration the first cost of the pigs and the dressed weight actually sold, we have the following: —

$867\frac{3}{4}$ pounds dressed weight actually sold at $7\frac{1}{4}$ cents,		$62 91
Total cost of food consumed,	$35 19	
Cost of pigs, at $3,	18 00	
		53 19
Total profit from pork,		$9 72
Value of manure produced,		10 00
Total profit from six pigs,		$19 72
Total profit per pig,		3 29
Cost of food to produce 1 pound live weight,		3.64 cts.
Cost of food to produce 1 pound dressed weight,		4.64 "
Net cost of food to produce 1 pound dressed weight (obtained by deducting value of manure produced),		3.30 "

The cost of the labor required to care for the pigs during their growth, as well as the cost of preparing them for the market, has not been deducted.

Market Cost of Foods consumed.

Corn meal,	$24 00 per ton.
Buffalo gluten feed,	23 00 per ton.
Skim-milk,	1.8 cents per gallon.

Percentage of the Essential Fertilizer Constituents in the Above Articles of Fodder, and the Commercial Value of the Constituents in 2,000 Pounds of the Foods.

[Nitrogen 15 cents, phosphoric acid 5½ cents, potassium oxide 4½ cents, per pound.]

	Corn Meal.	Gluten Feed.	Skim-milk.
	Per Cent.	Per Cent.	Per Cent.
Moisture,	11.38	6.82	90.50
Nitrogen,	1.80	3.81	0.52
Phosphoric acid,	0.70	0.30	0.19
Potassium oxide,	0.40	0.04	0.20
Valuation per 2,000 pounds,	$6 53	$11 81	$1 95
*Obtainable manurial value per ton,	4 57	8 28	1 36

* Allowing that thirty per cent of the nitrogen, potash and phosphoric acid is retained in the system of the growing animal.

NINETEENTH FEEDING EXPERIMENT WITH PIGS.

December, 1892, to April, 1893.

Six pigs were used in this experiment. They were divided into two lots of three each, and both lots were fed for the first ten days upon skim-milk and corn meal till they became accustomed to their new quarters. Pigs 1 and 4 were barrows, and Nos. 2, 3, 5 and 6 were sows. The pigs came from a Chester White sow, but as they grew Nos. 2, 3 and 6 showed plainly the Yorkshire characteristics. The general mode of treatment was quite similar to that described in the preceding experiment.

Object of the Experiment.

The object of the experiment was: First, a continuation of the many preceding experiments, in order to firmly establish facts relative to the most economical method of feeding skim-milk in combination with various grains and new concentrated fodder articles; in this case the experiment with Buffalo gluten feed was continued. Second, a step was taken in the direction of comparing the relative value of wide *vs.* narrow rations for economical pork production. In the many experiments heretofore made at this station, the general mode of feeding has been what might be termed narrow, *i. e.*, large quantities of nitrogenous matter in proportion to the non-nitrogenous and starchy matter have been fed. The feeding has generally begun with a ration of one part nitrogenous to three parts non-nitrogenous (1 : 3), and has been twice increased during the later feeding periods, till in the last of the three periods (in which the animal has increased in weight from 125 to 180 pounds) the ratio has been one part nitrogenous to four and one-half parts non-nitrogenous (1 : 4.5). Only in one or two cases have wider rations been fed. This method of feeding has been productive of most excellent results. The skim-milk has been most economically utilized, the animals have possessed uniformly good health and the pork has been produced at a comparatively low cost.

In case of three pigs in the present experiment wider rations were fed, beginning with 1 : 4.25 and ending with 1 : 6.5.

From the results obtained in this one experiment no very accurate conclusions can be drawn. What the experiment indicates can be seen from the figures presented further on, and it will be alluded to under our heading of "What our experiments teach us."

Experiments of this kind will be repeated, we hope, *in order to illustrate to our farmers* whether it is more economical to feed young growing pigs (from 25 to 180 pounds) in the beginning rations containing one part of nitrogenous to three parts non-nitrogenous matter (1 : 3), and ending with one part nitrogenous to four and one-half parts non-nitrogenous (1 : 4.5), or whether they can be fed as well or better with rations beginning with one part nitrogenous to four and one-half parts non-nitrogenous (1 : 4.5), and ending with one part nitrogenous to six and one-half parts non-nitrogenous (1 : 6.5).

How the Six Pigs were treated in the Present Experiment.

The pigs were divided into two lots of three each. Lot I., consisting of pigs 1, 2 and 3, was treated in practically the same way as in our previously described experiment. We had during a portion of the time a good supply of skim-milk, and each pig in this lot received at one time as high as ten quarts per day, in addition to his grain feed. The grain consisted of corn meal, and four ounces of Buffalo gluten feed as a substitute for one quart of milk, when the supply of the latter was limited. In case of Lot II. the number of feeding periods was the same, namely, three. During the first period the pigs were fed six ounces of corn meal to each quart of milk, and this continued until the pigs had reached a weight of 80 pounds, and were consuming four and one-half quarts of milk and twenty-seven ounces of corn meal per day. In periods II. and III. the supply of milk was kept at four quarts daily, plus two quarts of water to give the necessary drink, and as much corn meal was added as the animals would consume.

The following tables will, we believe, present concisely and clearly our method of feeding and the results obtained : —

Lot I.

Feeding Periods.	Composition of Ration.	Duration of Period.	Nutritive Ratio.
Period I., .	2 ounces corn meal to each quart milk, .	27 to 75 pounds live weight.	1:3
Period II., .	4 ounces corn meal to each quart milk, and 4 ounces gluten feed as a substitute for each quart milk.	75 to 120 pounds live weight.	1:3.6
Period III.,	6 ounces corn meal to each quart milk, and 4 ounces gluten feed as a substitute for each quart milk.	120 to 175 pounds live weight.	1:4.5

In Period II. of Lot I. we fed as high as ten quarts of skim-milk per day in addition to grain, while in Period III. the quantity of skim-milk, because of the limited supply, was reduced to four or five quarts per day.

Lot II.

Feeding Periods.	Composition of Ration.	Duration of Period.	Nutritive Ratio.
Period I., .	6 ounces corn meal to each quart milk, .	27 to 80 pounds live weight.	1:4.2
Period II., .	4 quarts skim-milk and 2 quarts water, and corn meal *ad libitum*.	80 to 120 pounds live weight.	1:5.3
Period III.,	4 quarts skim-milk and 2 quarts water, and corn meal *ad libitum*.	125 to 180 pounds live weight.	1:6.5

Summary of Results.

The experiment lasted one hundred and twenty-six days, and was productive of the following average results: —

Average Daily Gain.

	Period I. (Pounds).	Period II. (Pounds).	Period III. (Pounds).	Daily Average of One Hundred and Twenty-six Days (Pounds).
Lot I., ...	84	1.33	1.50	1.22
Lot II., ...	.92	1.30	1.60	1.27

	Lot I. Average of Three Pigs (Pounds).	Lot II. Average of Three Pigs. (Pounds).
Live weight, ...	172.71	180.75
Dressed weight, ...	140.75	148.00
Per cent. of loss in dressing, ...	18.53%	18.10%
Live weight gained during experiment, . .	146.17	152.00
Dressed weight gained during experiment, .	119.16	122.47
Dry matter required to produce 1 pound live weight, ...	2.82	2.57
Dry matter required to produce 1 pound dressed weight, ...	3.45	3.18

No difference in the amount of intestinal fat was observed in either lot.

Financial Statements.

No. I.

	Lot I.	Lot II.
Dressed pork actually produced during experiment (pounds), ...	357.5	367.4
Value at $7\frac{3}{4}$ cents per pound (market price), .	$27 71	$28 47
Cost of food consumed, ...	19 95	18 02
Profit from pork actually produced, . . .	$7 76	$10 45
Value of manure produced, ...	6 05	4 41
Total profit from three pigs, ...	$13 81	$14 86
Profit per pig, ...	4 60	4 95

If we take into consideration the first cost of the pigs and the dressed weight actually sold, we have the following record for both lots: —

No. II.

866.25 pounds dressed pork actually sold, at $7\frac{3}{4}$ cents,		$67 13
Total cost of food consumed,	$39 05	
Cost of pigs, at $2.25 each,	13 50	
		52 55
Profit from pork,		$14 58
Value of manure produced,		11 38
Total profit from six pigs,		$25 96
Profit per pig,		4 33

	Lot I. (Cents).	Lot II. (Cents).
Cost of food to produce 1 pound live weight,	4.55	3.95
Cost of food to produce 1 pound dressed weight,	5.58	4.91
Net cost of food to produce 1 pound dressed weight (obtained by deducting value of manure produced from cost of food),	3.88	3.90

Market Cost of Foods consumed.

Corn meal,	$23 00 per ton.
Gluten feed,	21 00 per ton.
Skim-milk,	1.8 cents per gallon.

The *percentages* of the essential fertilizer constituents in the above articles of fodder, their *commercial value* in 2,000 pounds, as well as their approximate *obtainable manurial value* when fed to growing pigs, may be seen from the following: —

[Nitrogen at $17\frac{1}{2}$ cents, phosphoric acid at 5 cents, and potassium oxide at $5\frac{1}{2}$ cents, per pound.]

	Per Cent.	Per Cent.	Per Cent.
Moisture,	14.00	7.55	90.24
Nitrogen,	1.36	3.55	.51
Phosphoric acid,	.707	.296	.18
Potash,	.435	.045	.19
Valuation per 2,000 pounds,	$5 95	$12 70	$2 17
Obtainable manurial value,	4 17	8 89	1 52

What our Experiments teach.

Briefly stated, from a practical stand-point, these two experiments and many others made at the station teach us the following lessons: —

I. Skim-milk, together with corn meal, gluten meal, wheat bran, gluten feed, maize feed, etc., combined as above stated, have proved healthy and profitable foods for the production of pork for our markets.

II. With skim-milk reckoned at 1.8 cents per gallon, gluten feed from $21 to $23 per ton and corn meal at $23 to $24 per ton, we have been enabled in these experiments to produce dressed pork at from 4.6 to 5.3 cents per pound. The net cost of the dressed pork produced (obtained by deducting the value of the manure produced) was from 3.3 to 3.8 cents per pound.

III. Farmers having a quantity of skim-milk at their disposal can utilize it profitably by feeding it to growing pigs, as above described. If this milk can be sold, however, at one cent per quart, or more, it would undoubtedly be more profitable to sell it than to use it in the production of pork.

IV. Experiments made at this station have proved that it is not profitable to feed pigs after they reach a weight of 180 to 190 pounds, excepting perhaps when pork commands an exceptionally high price. Fed beyond this weight, the food consumed increases and the percentage of gain in live weight steadily decreases, so that the daily cost of food consumed is more than the value of the daily increase in weight. This fact has since been confirmed by other stations.

V. In the last experiment, Lot II. gave slightly more favorable results than Lot I. These results are not decisive enough to enable us to make any deductions, especially when the results of previous experiments at this station with narrow rations, and experiments elsewhere with both wide and narrow rations, are considered. Repeated trials are necessary to establish facts.

Practical Rations for Pig Feeding.

When skim-milk is used as a part of the daily diet in feeding pigs for the market, the station feels justified, in view of its feeding experiments, in recommending the following practical rations as being valuable in producing pork at a minimum cost: —

I.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	2 ounces corn meal to each quart milk,* .	1:3.30
80 to 125, .	4 ounces corn meal to each quart milk, . .	1:4.00
125 to 190, .	6 ounces corn meal to each quart milk, . .	1:4.50

* Creamery buttermilk can be substituted for skim-milk as above with good results if it can be had at a reasonable price, say 1.4 cents per gallon.

When skim-milk is in limited supply, from four to six quarts per pig.

II.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	Milk at disposal, and one part by weight wheat bran, two parts by weight gluten meal, to satisfy appetite.	1:3.20
80 to 120, .	Milk at disposal and following mixture: one weight part corn meal, one weight part wheat bran, one weight part gluten meal, to satisfy animal.	1:4.00
125 to 190, .	Milk at disposal and following mixture: two weight parts corn meal, one weight part wheat bran, one weight part gluten meal.	1:4.50

III.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	2 ounces corn meal to each quart of milk and 4 ounces gluten feed as a substitute for each quart milk.	1:3.25 to 4.00
80 to 120, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one part by weight corn meal.	1:4.00 to 4.40
125 to 190, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one and one-half parts by weight corn meal.	1:4.4 to 4.9

Analysis of Fodder Articles used in our Pig-feeding Experiments.

Corn Meal.

Average Analysis.

	Used in 18th Experiment.		Used in 19th Experiment.		Per Cent. of Digestibility of Constituents of Corn Meal.
	Percentage Composition.	Nutritive Ratio.	Percentage Composition.	Nutritive Ratio.	
Moisture at 100° C., . . .	11.38	–	14.00	–	–
Dry matter, ...	88.62	–	86.00	–	–
	100.00	–	100.00	–	–
Analysis of Dry Matter.					
Crude ash, ...	1.63	1 : 10.65	1.50	1 : 10.00	–
" cellulose, . . .	2.13		2.58		40
" fat, ...	4.63		2.44		76
" protein, ...	10.71		9.87		86
Non-nitrogenous extract matter,	80.90		83.61		95
	100.00		100.00		–

Buffalo Gluten Feed.

Average Analysis.

	Used in 18th Experiment.		Used in 19th Experiment.		Per Cent of Digestibility of Constituents of Gluten Feed.
	Percentage Composition.	Nutritive Ratio.	Percentage Composition.	Nutritive Ratio.	
Moisture at 100° C., ...	6.82	–	7.55	–	–
Dry matter, ...	93.18	–	92.45	–	–
	100.00	–	100.00	–	–
Analysis of Dry Matter.					
Crude ash, ...	0.83	1 : 3.46	0.85	1 : 3.80	–
" cellulose, . . .	4.94		10.06		40
" fat, ...	13.03		12.48		76
" protein, ...	28.71		23.86		86
Non-nitrogenous extract matter,	52.49		52.75		95
	100.00		100.00		–

Skim-milk.

Average Analysis.

	Used in 18th Experiment.		Used in 19th Experiment.		Per Cent. of Digestibility of Constituents of Skim-milk.
	Percentage Composition.	Nutritive Ratio.	Percentage Composition.	Nutritive Ratio.	
Moisture at 100° C., ...	90.50	–	90.24	–	–
Dry matter, ...	9.50	–	9.76	–	–
	100.00	–	100.00	–	–
Analysis of Dry Matter.					
Crude ash, ...	6.82	1 : 2.15	8.09	1 : 1.93	–
" fat, ...	4.00		2.66		100
" protein, ...	31.50		32.66		100
Non-nitrogenous extract matter,	57.68		56.59		100
	100.00		100.00		–

EIGHTEENTH EXPERIMENT.

Detailed Record.

Pig No. 1.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
Aug. 9 to Oct. 4, .	38.25	268.00	9.50	1 : 3.37	25.50	78.00	0.94
Oct. 4 to Nov. 1, .	58.00	140.00	26.63	1 : 4.47	78.00	126.00	1.71
Nov. 1 to Nov. 29, .	91.88	113.00	62.31	1 : 4.81	126.00	182.50	2.02

Total Amount of Feed consumed from Aug. 9 to Nov. 29, 1892.

	Dry Matter (Pounds).	Total Cost	Manurial Value Obtainable.	Net Cost.
188.13 pounds corn meal, . .	161.77	$2 26	$0 42	$1 84
521.00 quarts skim-milk, . .	107.63	2 34	0 77	1 57
98.44 pounds gluten feed, . .	91.67	1 13	0 43	0 70
.	361.07	$5 73	$1 62	$4 11

Live weight of animal at the beginning of the experiment, 25.50 lbs.
Live weight of animal at the time of killing, ... 182.50 "
Live weight gained during the experiment, ... 157.00 "
Dressed weight of animal, ... 143.00 "
Loss in weight by dressing, 21.64 per cent, ... 39.50 "
Dressed weight gained during the experiment, ... 123.02 "
Pounds of dry matter fed produced 1 pound of live weight, 2.30 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 2.94 "
Total cost of feed per pound of dressed weight gained, . 4.66 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent of manurial value, ... 3.35 "

Pig No. 2.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
Aug. 9 to Oct. 4, .	38.25	268.00	9.50	1 : 3.37	28.50	81.00	0.94
Oct. 4 to Nov. 1, .	58.00	140.00	26.63	1 : 4.47	81.00	127.75	1.67
Nov. 1 to Nov. 29, .	85.25	113.00	55.50	1 : 4.85	127.75	183.75	2.00

Total Amount of Feed consumed from Aug. 9 to Nov. 29, 1892.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
181.50 pounds corn meal, . .	156.07	$2 18	$0 41	$1 77
521.00 quarts skim-milk, . .	107.63	2 34	0 77	1 57
91.63 pounds gluten feed, . .	85.38	1 05	0 41	0 64
	349.08	$5 57	$1 59	$3 98

Live weight of animal at the beginning of the experiment,	28.50 lbs.
Live weight of animal at the time of killing, . . .	183.75 "
Live weight gained during the experiment, ...	155.25 "
Dressed weight of animal, ...	145.25 "
Loss in weight by dressing, 24.80 per cent, ...	38.50 "
Dressed weight gained during the experiment, . . .	116.75 "
Pounds of dry matter fed produced 1 pound of live weight,	2.25 "
Pounds of dry matter fed produced 1 pound of dressed weight, ...	2 98 "
Total cost of feed per pound of dressed weight gained, .	4.77 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent of manurial value, ...	3.41 "

Pig No. 3.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
Aug. 9 to Oct. 4, .	38.25	268.00	9.50	1 : 3.37	30.50	84.00	0.96
Oct. 4 to Nov. 1, .	58.00	140.00	26.63	1 : 4.47	84.00	130.00	1.67
Nov. 1 to Nov. 29, .	88.75	113.00	57.69	1 : 4.94	130.00	183.75	1.92

Total Amount of Feed consumed from Aug. 9 to Nov. 29, 1892.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
185.00 pounds corn meal, . .	159.08	$2 23	$0 42	$1 81
521.00 quarts skim-milk, . .	107.63	2 34	0 77	1 57
93.82 pounds gluten feed, . .	87.42	1 08	0 41	0 67
	354.13	$5 65	$1 60	$4 05

Live weight of animal at the beginning of the experiment, 30.50 lbs.
Live weight of animal at the time of killing, ... 183.75 "
Live weight gained during the experiment, ... 153.25 "
Dressed weight of animal, ... 144.50 "
Loss in weight by dressing, 21.36 per cent, ... 39.25 "
Dressed weight gained during the experiment, . . . 119.68 "
Pounds of dry matter fed produced 1 pound of live weight, 2.31 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 2.96 "
Total cost of feed per pound of dressed weight gained, . 4.72 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent of manurial value, ... 3.38 "

Pig No. 4.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
Aug. 9 to Oct. 4, .	38.25	268.00	9.50	1 : 3.37	24.00	82.00	1.04
Oct. 4 to Nov. 1, .	58.00	140.00	26.63	1 : 4.47	82.00	125.00	1.54
Nov. 1 to Nov. 29, .	88.88	113.00	58.00	1 : 4.94	125.00	181.50	2.02

Total Amount of Feed consumed from Aug. 9 to Nov. 29, 1892.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
185.13 pounds corn meal, . .	159.19	$2 23	$0 42	$1 81
521.00 quarts skim-milk, . .	107.63	2 34	0 77	1 57
94.13 pounds gluten feed, . .	87.71	1 09	0 41	0 68
	354.53	$5 66	$1 60	$4 06

Live weight of animal at the beginning of the experiment, 24.00 lbs.
Live weight of animal at the time of killing, . . . 181.50 "
Live weight gained during the experiment, ... 157.50 "
Dressed weight of animal, ... 144.00 "
Loss in weight by dressing, 20.66 per cent, ... 37.50 "
Dressed weight gained during the experiment, . . . 124.97 "
Pounds of dry matter fed produced 1 pound of live weight, 2.25 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 2.84 "
Total cost of feed per pound of dressed weight gained, . 4.53 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent of manurial value, ... 3.28 "

Pig No. 5.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
Aug. 9 to Oct. 4, .	38.25	268.00	9.50	1:3.37	24.50	75.75	0.92
Oct. 4 to Nov. 1, .	58.00	140.00	26.63	1:4.47	75.75	124.75	1.75
Nov. 1 to Nov. 29, .	90.00	113.00	59.56	1:4.94	124.75	182.25	2.05

Total Amount of Feed consumed from Aug. 9 to Nov. 29, 1892.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
186.25 pounds corn meal, . .	160.16	$2 23	$0 42	$1 81
521.00 quarts skim-milk, . .	107.63	2 34	0 77	1 57
95.69 pounds gluten feed, . .	89.16	1 10	0 41	0 69
	356.95	$5 67	$1 60	$4 07

Live weight of animal at the beginning of the experiment, 24.50 lbs.
Live weight of animal at the time of killing, ... 182.25 "
Live weight gained during the experiment, ... 157.75 "
Dressed weight of animal, ... 144.00 "
Loss in weight by dressing, 20.98 per cent, ... 38.25 "
Dressed weight gained during the experiment, ... 124.73 "
Pounds of dry matter fed produced 1 pound of live weight, 2.26 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 2.88 "
Total cost of feed per pound of dressed weight gained, . 4.55 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent of manurial value, ... 3.21 "

Pig No. 6.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Gluten Feed consumed (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892.							
Aug. 9 to Oct. 4, .	38.25	268.00	9.50	1 : 3.37	30.00	81.00	0.91
Oct. 4 to Nov. 1, .	58.00	140.00	26.63	1 : 4.47	81.00	124.00	1.54
Nov. 1 to Nov. 29, .	89.37	113.00	58.75	1 : 4.94	124.00	183.00	2.11

Total Amount of Feed consumed from Aug. 9 to Nov. 29, 1892.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable	Net Cost.
185.62 pounds corn meal, . .	159.61	$2 23	$0 42	$1 81
521.00 quarts skim-milk, . .	107.63	2 34	0 77	1 57
94.88 pounds gluten feed, . .	88.41	1 09	0 41	0 68
	355.65	$5 66	$1 60	$4 06

Live weight of animal at the beginning of the experiment,	30.00 lbs.
Live weight of animal at the time of killing, ...	183.00 "
Live weight gained during the experiment, ...	153.00 "
Dressed weight of animal, ...	147.00 "
Loss in weight by dressing, 19.67 per cent, ...	36.00 "
Dressed weight gained during the experiment, ...	1.23 "
Pounds of dry matter fed produced 1 pound of live weight,	2.32 "
Pounds of dry matter fed produced 1 pound of dressed weight, ...	2.88 "
Total cost of feed per pound of dressed weight gained, .	4.60 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent of manurial value, ...	3.26 "

NINETEENTH EXPERIMENT.

Detailed Record.

Pig No. 1.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Gluten Feed consumed (Pounds).	Skim-milk consumed (Quarts).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892-93.							
Dec. 13 to Feb. 7,	43.25	6.25	321.00	1 : 3.00	27.50	77.00	0.88
Feb. 7 to Mar. 14,	49.00	33.25	198.00	1 : 3.65	77.00	122.50	1.28
Mar. 14 to Apr. 18,	120.00	27.81	247.00	1 : 4.50	122.50	175.00	1.53

Total Amount of Feed consumed from Dec. 13, 1892, to April 18, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
212.25 pounds corn meal, . .	182.54	$2 44	$0 44	$2 00
67.31 pounds gluten feed, . .	62.23	0 71	0 30	0 41
766.00 quarts skim-milk, . .	162.23	3 45	1 26	2 19
	407.00	$6 60	$2 00	$4 60

Live weight of animal at the beginning of the experiment, 27.50 lbs.
Live weight of animal at the time of killing, ... 175.00 "
Live weight gained during the experiment, ... 147.50 "
Dressed weight of animal, ... 144.00 "
Loss in weight by dressing, 17.95 per cent., ... 31.50 "
Dressed weight gained during the experiment, ... 121.45 "
Pounds of dry matter fed produced 1 pound of live weight, 2.78 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 3.35 "
Total cost of feed per pound of dressed weight gained, . 5.43 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent. of manurial value, ... 3.79 "

Pig No. 2.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Gluten Feed consumed (Pounds).	Skim-milk consumed (Quarts).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892-93.							
Dec. 13 to Feb. 7,	43.25	6.25	321.00	1 : 3.00	25.25	69.50	0.79
Feb. 7 to Mar. 14,	51.50	35.00	206.00	1 : 3.65	69.50	113.50	1.26
Mar. 14 to Apr. 18,	126.89	30.81	253.00	1 : 4.50	113.50	176.00	1.78

Total Amount of Feed consumed from Dec. 13, 1892, to April 18, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
221.64 pounds corn meal, . .	190.61	$2 55	$0 46	$2 09
74.56 pounds gluten feed, . .	68.93	0 72	0 33	0 39
780.00 quarts skim-milk, . .	165.20	3 51	1 28	2 23
	424.74	$6 78	$2 07	$4 71

Live weight of animal at the beginning of the experiment,	25.25 lbs.
Live weight of animal at the time of killing, . . .	176.00 "
Live weight gained during the experiment, ...	150.75 "
Dressed weight of animal, ...	140.00 "
Loss in weight by dressing, 20.45 per cent., ...	36.00 "
Dressed weight gained during the experiment, . . .	119.92 "
Pounds of dry matter fed produced 1 pound of live weight,	2.82 "
Pounds of dry matter fed produced 1 pound of dressed weight, ...	3.54 "
Total cost of feed per pound of dressed weight gained, .	5.65 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent. of manurial value, ...	3.93 "

Pig No. 3.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Gluten Feed consumed (Pounds).	Skim-milk consumed (Quarts).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892-93.							
Dec. 13 to Feb. 7,	43.25	6.25	318.00	1 : 3.00	26.75	77.75	0.91
Feb. 7 to Mar. 14,	51.50	35.00	206.00	1 : 3.60	77.75	125.25	1.36
Mar. 14 to Apr. 18,	111.50	21.75	251.00	1 : 4.40	125.25	167.00	1.19

Total Amount of Feed consumed from Dec. 13, 1892, to April 18, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
206.25 pounds corn meal, . .	177.36	$2 37	$0 43	$1 94
63.00 pounds gluten feed, . .	58.24	0 66	0 28	0 38
775.00 quarts skim-milk, . .	164.14	3 49	1 27	2 22
	399.74	$6 52	$1 98	$4 54

Live weight of animal at the beginning of the experiment, 26.75 lbs.
Live weight of animal at the time of killing, ... 167.00 "
Live weight gained during the experiment, ... 140.25 "
Dressed weight of animal, ... 138.25 "
Loss in weight by dressing, 17.22 per cent., ... 28.75 "
Dressed weight gained during the experiment, ... 116.11 "
Pounds of dry matter fed produced 1 pound of live weight, 2.85 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 3.45 "
Total cost of feed per pound of dressed weight gained, . 5.61 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent. of manurial value, ... 3.91 "

Pig No. 4.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892-93.						
Dec. 13 to Feb. 7,	75.38	201.00	1 : 4.20	30.00	81.00	0.91
Feb. 7 to Mar. 14,	98.13	140.00	1 : 5.30	81.00	127.00	1.30
Mar. 14 to Apr. 18,	172.50	138.00	1 : 6.50	127.00	188.00	1.74

Total Amount of Feed consumed from Dec. 13, 1892, to April 18, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
346.00 pounds corn meal, . .	297.56	$3 98	$0 72	$3 26
479.00 quarts skim-milk, . .	101.45	2 15	0 78	1 37
	399.01	$6 13	$1 50	$4 63

Live weight of animal at the beginning of the experiment, 30.00 lbs.
Live weight of animal at the time of killing, . . . 188.00 "
Live weight gained during the experiment, ... 158.00 "
Dressed weight of animal, ... 150.50 "
Loss in weight by dressing, 20.00 per cent., ... 37.50 "
Dressed weight gained during the experiment, . . . 120.51 "
Pounds of dry matter fed produced 1 pound of live weight, 2.52 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 3.31 "
Total cost of feed per pound of dressed weight gained, . 5.09 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent. of manurial value, ... 3.84 "

Pig No. 5.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds)
1892-93.						
Dec. 13 to Feb. 7,	75.38	201.00	1 : 4.20	26.25	81.00	0.98
Feb. 7 to Mar. 14,	97.88	139.00	1 : 5.30	81.00	126.00	1.30
Mar. 14 to Apr. 18,	162.44	137.00	1 : 6.45	126.00	173.00	1.34

Total Amount of Feed consumed from Dec. 13, 1892, to April 18, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
335.70 pounds corn meal, . .	288.70	$3 86	$0 69	$3 17
477.00 quarts skim-milk, . .	101.02	2 14	0 78	1 36
	389.72	$6 00	$1 47	$4 53

Live weight of animal at the beginning of the experiment, 26.25 lbs.
Live weight of animal at the time of killing, ... 173.00 "
Live weight gained during the experiment, ... 146.75 "
Dressed weight of animal, ... 143.50 "
Loss in weight by dressing, 17.05 per cent., ... 29.50 "
Dressed weight gained during the experiment, ... 121.73 "
Pounds of dry matter fed produced 1 pound of live weight, 2.66 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 3.20 "
Total cost of feed per pound of dressed weight gained, . 4.93 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent. of manurial value, ... 3.72 "

Pig No. 6.

FEEDING PERIODS.	Corn Meal consumed (Pounds).	Skim-milk consumed (Quarts).	Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Gain in Weight per Day (Pounds).
1892-93.						
Dec. 13 to Feb. 7,	75.38	201.00	1 : 4.20	30.00	76.00	0.82
Feb. 7 to Mar. 14,	93.38	132.00	1 : 5.30	76.00	121.50	1.30
Mar. 14 to Apr. 18,	157.68	138.00	1 : 6.40	121.50	181.25	1.71

Total Amount of Feed consumed from Dec. 13, 1892, to April 18, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.	Net Cost.
326.44 pounds corn meal, . .	280.74	$3 76	$0 67	$3 09
471.00 quarts skim-milk, . .	99.75	2 12	0 77	1 35
	380.49	$5 88	$1 44	$4 44

Live weight of animal at the beginning of the experiment, 30.00 lbs.
Live weight of animal at the time of killing, ... 181.25 "
Live weight gained during the experiment, ... 151.25 "
Dressed weight of animal, ... 150.00 "
Loss in weight by dressing, 17.24 per cent., ... 31.25 "
Dressed weight gained during the experiment, ... 125.17 "
Pounds of dry matter fed produced 1 pound of live weight, 2.52 "
Pounds of dry matter fed produced 1 pound of dressed weight, ... 3.04 "
Total cost of feed per pound of dressed weight gained, . 4.70 cts.
Net cost of feed per pound of dressed weight gained, after deducting 30 per cent. of manurial value, ... 3.55 "

V.

FEEDING EXPERIMENTS WITH CALVES.

One of the chief sources of profit to Massachusetts farmers is the dairy industry. The creamery system is now generally in vogue, and there remains upon the farms the skim-milk, the cream having been taken to the factory. How to economically utilize this milk is a very important question, for upon its disposition depends in no small degree the profit or loss from the herd of cows.

Object of the Experiment.

For a number of years experiments have been carried on at the station with growing pigs. The pigs were fed the skim-milk in combination with various grain rations, and one of the objects aimed at was to ascertain the returns per quart for the skim-milk fed. Further on will be found a statement of the results obtained on the basis of the different selling prices of dressed pork.

With the facts in hand, the next object was to see *what price could be obtained per quart for the skim-milk when fed to young calves*, either alone or in combination with various other materials. Following these brief remarks is a description of the experiment.

Description of the Experiment.

A detailed statement of the record of each calf will be found at the end of the experiment. Calves Nos. 1, 2, 3 and 4 were fed for the first seven to ten days equal parts of fresh and skim milk; then they were quickly brought to a skim-milk diet exclusively. The milk was always given lukewarm. After the first few weeks, in addition to the milk various grains were fed *ad libitum*, and with one exception in a dry state. It is well known that the stomachs of young

calves are exceedingly delicate. During the first two months of their lives they are not able to digest any large quantities of grain; but if the grain is placed before them in a dry state, they will not consume enough to injure them. Beginning with one-fourth of a pound per day, the calves consumed as high as one pound daily by the time they were eight weeks old. These calves drank ten to twelve quarts of milk daily in addition to the grain consumed. The object in feeding the grain was to furnish in a measure the carbohydrates necessary to prevent the rapid destruction of the albuminoids in the animal system that would otherwise follow.

Skim-milk has a nutritive ratio of about 1:2. With a ratio of but two carbohydrates to one of protein, it would not be possible to produce any amount of fat; neither is a feed with such a narrow ratio the most economical one. The calves, however, were not able to consume grain enough to widen the ratio sufficiently to enable them to put on the fat desired.

Scours were noticed in case of calves 2 and 3, which prevented the best results, but the trouble was eventually overcome.

Calves Nos. 5, 6 and 7, with the exception of the first ten days, when equal parts of whole and skim milk were fed, had no other food than skim-milk during the entire experiment. Calf 5, however, for a brief period received a small amount of grain, and calf 7 a small quantity of cod liver oil, to see if any benefit could be observed from its use, both from its general effect upon the system and from its fat-producing qualities. A small quantity (tablespoonful) of lime water was added to the skim-milk at each feeding.

At the beginning of the experiment they consumed six quarts of milk daily, while at the end, with skim-milk as an exclusive food, they drank from sixteen to twenty quarts per day.

The time required to teach the calves to drink was about three days. The calves were kept in separate pens, and weighed weekly. They were kept until they were eight to eleven weeks old.

Record of Calves.

Showing Price per Quart obtained for Skim-milk fed.

Calf 1.

Age when received: three days.

Breed: grade Shorthorn, bull

Grain stirred into the milk.

Foods fed: equal parts of whole milk and skim-milk for the first few days, then skim-milk only, with as much corn meal as the animal would consume.

Financial Statement.

	Debit.	Credit.
Original cost of calf,	$1 00	-
55.2 pounds corn meal, at $23 per ton,	0 63	-
10 quarts fresh milk, at 3 cents,	0 30	-
177 pounds live weight, at 4½ cents,	-	$7 96
489 quarts skim-milk returned,	6 03	-
	$7 96	$7 96

	Cents.
Price returned per quart for skim-milk fed,	1.23
Price returned per quart for skim-milk fed, when live weight brings 4 cents per pound,	1.05

Calf 2.

Age when received: three days.

Breed: grade Jersey, heifer.

Grain consumed dry.

Foods fed: equal parts of skim and whole milk for two weeks (for one week only whole milk, on account of scours), later skim-milk with corn meal, and afterwards equal parts of Buffalo gluten feed and old-process linseed meal *ad libitum.*

CALF 2 — Concluded.

Financial Statement.

	Debit.	Credit.
Original cost of calf,	$1 00	–
8.10 pounds corn meal, at $23 per ton,	0 09	–
8.44 pounds gluten feed, at $20 per ton,	0 08	–
8.44 pounds old-process linseed meal, at $26 per ton,	0 11	–
83.50 quarts whole milk, at 3 cents,	2 50	–
177.50 pounds live weight, at 4½ cents,	–	$7 89
555.50 quarts skim-milk returned,	4 11	–
	$7 89	$7 89

	Cents.
Price returned per quart for skim-milk fed,	0.74
Price returned per quart for skim-milk fed, when live weight brings 4 cents per pound,	0.60

CALF 3.

Age when received: two days.

Breed: grade Ayrshire, heifer.

Grain fed dry.

Foods fed: equal parts of whole milk and skim-milk for the first two weeks (for one week whole milk only, on account of scours), and later skim-milk with equal parts of Buffalo gluten feed and old-process linseed meal.

Financial Statement.

	Debit.	Credit.
Original cost of calf,	$1 00	–
16.10 pounds gluten feed, at $20 per ton,	0 16	–
16.10 pounds old-process linseed meal, at $26 per ton,	0 20	–
77.00 quarts whole milk, at 3 cents,	2 31	–
160.25 pounds live weight, at 4½ cents,	–	$7 21
799.00 quarts skim-milk returned,	3 54	–
	$7 21	$7 21

	Cents.
Price returned per quart for skim-milk fed,	0.44
Price returned per quart for skim-milk fed, when live weight brings 4 cents per pound,	0.34

Calf 4.

Age when received: two days.

Breed: grade Durham, heifer.

Grain consumed dry.

Foods fed: equal parts of fresh and skim milk during first nine days, then skim-milk and wheat flour, followed for a few days by skim-milk and equal parts of wheat flour and old-process linseed meal, and finally skim-milk and equal parts of Buffalo gluten feed and wheat middlings.

Financial Statement.

	Debit.	Credit.
Original cost of calf,	$1 00	–
6.56 pounds wheat flour, at 2 cents,	0 13	–
1.90 pounds old-process linseed meal, at $26 per ton,	0 03	–
13.31 pounds gluten feed, at $20 per ton,	0 13	–
12.44 pounds wheat middlings, at $22 per ton,	0 14	–
32.00 quarts fresh milk, at 3 cents,	0 96	–
185.00 pounds live weight, at 4½ cents,	–	$8 32
873.00 quarts skim-milk returned,	5 93	–
	$8 32	$8 32

	Cents.
Price returned per quart for skim-milk fed,	0.68
Price returned per quart for skim-milk fed, when live weight brings 4 cents per pound,	0.57

Calf 5.

Age when received: three days.

Breed: grade unknown, heifer.

Foods fed: equal parts of fresh and skim milk for the first week, and after that (excepting skim-milk and a small amount of equal parts of Buffalo gluten feed and wheat middlings) skim-milk entirely.

CALF 5 — *Concluded.*

Financial Statement.

	Debit.	Credit.
Original cost of calf, ...	$1 00	-
2.40 pounds wheat middlings, at $22 per ton, .	0 03	-
2.40 pounds gluten feed, at $20 per ton, . .	0 02	-
27.00 quarts fresh milk, at 3 cents, ...	0 81	-
189.25 pounds live weight, at 4½ cents, . . .	-	$8 51
936.50 quarts skim-milk returned, ...	6 65	-
	$8 51	$8 51

	Cents.
Price returned per quart for skim-milk fed, ...	0.71
Price returned per quart for skim-milk fed, when live weight brings 4 cents per pound, ...	0.61

CALF 6.

Age when received: three days.

Breed: grade Holstein, heifer.

Foods fed: for first nine days equal parts of whole and skim milk and then skim-milk only.

Financial Statement.

	Debit.	Credit.
Original cost of calf, ...	$1 25	-
40.00 quarts fresh milk, at 3 cents, ...	1 20	-
166.50 pounds live weight, at 4 cents, . . .	-	$6 66
617.00 quarts skim-milk returned, ...	4 21	-
	$6 66	$6 66

	Cents.
Price returned per quart for skim-milk fed, ...	0.68
Price returned per quart for skim-milk fed, when live weight brings 4½ cents per pound, ...	0.82

Calf 7.

Age when received: three days.

Breed: grade Shorthorn, heifer.

Foods fed: for first nine days equal parts of whole and skim milk, afterwards skim-milk exclusively, excepting twenty-five ounces of cod liver oil in addition to milk during nineteen days.

Financial Statement.

	Debit.	Credit.
Original cost of calf,	$1 00	–
25.00 ounces cod liver oil, at 2.4 cents,	0 60	–
34.00 quarts whole milk, at 3 cents,	1 02	–
157.25 pounds live weight, at 4 cents,	–	$6 28
621.00 quarts skim-milk returned,	3 66	–
	$6 28	$6 28

	Cents.
Price returned per quart for skim-milk fed,	0.59
Price returned per quart for skim-milk fed, when live weight brings $4\frac{1}{2}$ cents per pound,	0.72

Summary of Above Results.

1. Price returned per quart for skim-milk, when live weight sells at $4\frac{1}{2}$ cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.77
Calves 5, 6 and 7 (skim-milk alone),	0.75
Average of seven calves,	0.76

2. Price returned per quart for skim-milk, when live weight sells at 4 cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.64
Calves 5, 6 and 7 (skim-milk alone),	0.63
Average of seven calves,	0.63

Additional Interesting Facts (*Average of Seven Calves*).

Average daily gain in live weight, ...	1.49 pounds.
Dry matter required to produce 1 pound live weight, .	1.77 pounds.
Dry matter required to produce 1 pound dressed weight, .	2.98 pounds.
Shrinkage in dressing, ...	44.22 per cent.
Average number of weeks fed, ...	10

Price obtained for Skim-milk per Quart when fed to Pigs.

Below are the average results obtained from experiments with forty pigs, being six distinct lots, fed during the years 1890–91 and 1892–93. In this number grade Chester Whites predominated, but several Yorkshires, Berkshires, Poland Chinas and Tamworths are also included. During this time the grains fed had the following average cost per ton: —

Corn meal, ...	$24 50
Wheat bran, ...	22 30
Buffalo gluten feed, ...	24 40
Chicago gluten meal, ...	25 00

The system of pig feeding developed at the station is generally known. Those not familiar with the experiments will find the methods described in this report at the end of the feeding experiments with pigs under the heading "Practical rations for pig feeding."

To obtain the returns per quart for skim-milk, the original cost of the pig plus the cost of the grains fed are deducted from the value obtained for the dressed weight. The difference represents the value of the skim-milk. See also the same method in the calf experiment.

Statement.

[Cents.]

Dressed Pork sold at —	5½ Cents.	6 Cents.	6½ Cents.	7 Cents.	7½ Cents.	8 Cents.
Price returned per quart for skim-milk fed, . . .	0.21	0.30	0.46	0.58	0.70	0.81

Comments on the Results.

The experiments have shown that calves grown upon skim-milk alone or upon skim-milk and grains during the first eight weeks of their lives make good gains in live weight, namely, from 0.9 to 2.13 pounds per day, with an average of 1.49 pounds. These animals, however, put on very little fat, either when fed on skim-milk alone or when fed on skim-milk and grains. They were not able to digest the necessary amount of corn meal, Buffalo gluten feed, or wheat flour or middlings, when fed in connection with the nitrogenous milk, to promote the formation of fat.

The meat of the animals thus described was quite white in appearance, but not as tender as calves that were fed whole milk. The ribs and flanks of animals thus fed were thinner than those consuming whole milk, and the shrinkage in dressing is from 5 to 7 per cent. more.

Butchers offered from 4 to 4½ cents per pound of live weight, whole-milk veal being worth at the time 5½ to 6 cents per pound. It is to be remarked, however, that at retail as much per pound was charged for the skim-milk as for the whole-milk veal. It will be noticed that when skim-milk veal, so called, brought 4 cents per pound of live weight, an average of 0.63 of a cent per quart or 2.52 cents per gallon was obtained for the skim-milk fed; while when live weight brought 4½ cents per pound the return for the skim-milk was 0.76 of a cent per quart, or 3 cents per gallon. When the skim-milk was fed to pigs, and dressed pork brought 5½ cents per pound, there was a return of 0.2 of a cent per quart for the milk; and when dressed pork brought 7 cents per pound, 0.6 of a cent was obtained per quart for the milk, and 0.7 of a cent was obtained when dressed pork brought 7½ cents per pound.

These results are interesting and instructive, and worthy of the careful consideration of dairy farmers. It must be admitted that calves require rather more attention than pigs. The milk must not be sour and must be fed warm, and their condition must be carefully watched lest they be attacked with scours. A small quantity of lime water added to the milk at each feeding seems to act as a preventive.

No beneficial results were noticed when cod liver oil was fed in small quantities to calf 7. Its smell and taste were obnoxious to the calf, and quite often he refused the milk containing it.

The experiment indicates that, in order to secure the greatest profit, it is not wise as a rule to feed calves as above described after they have reached 160 pounds of live weight. The daily gain decreases and the food consumption steadily increases, so that the commercial value of a pound of live weight is about balanced by the cost of the food consumed to produce it.

This experiment is presented as the beginning of a series designed for the purpose of studying the most economical way in which to feed skim-milk to growing calves, especially to calves intended for veal. Whole milk forms a complete food for calves, and by its use they can be sold from five to seven weeks from birth in a fat condition. How to secure a food equal in its effect to whole milk by utilizing the skim-milk and substituting a cheaper fattening material in place of the cream removed, is the problem for future solution.

TABLES SHOWING AVERAGE DAILY FOOD CONSUMPTION AND GAIN IN LIVE WEIGHT.

CALF 1.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds)	Average Daily Amount of Grain consumed (Ounces).	AVERAGE DAILY AMOUNT OF MILK CONSUMED	
			Fresh Milk (Quarts).	Skim-milk (Quarts).
April 4-7, . . .	–	–	3.33	4.70
14, . . .	99.50	7.14	–	8.86
21, . . .	117.25	10.00	–	10.00
28, . . .	132.25	12.86	–	10.00
May 4, . . .	160.25	16.71	–	11.43
11, . . .	167.75	20.00	–	9.71
18, . . .	180.25	28.57	–	8.00
25, . . .	177.00	21.14	–	7.57
27, . . .	177.00	28.00	–	8.00
Total gain in 54 days,	77.50	18.05	–	8.70
Average daily gain, .	1.43	–	–	–

CALF 2.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	Average Daily Amount of Grain consumed (Ounces).	AVERAGE DAILY AMOUNT OF MILK CONSUMED. Fresh Milk (Quarts).	Skim-milk (Quarts).
April 18, . . .	74.00	–	–	–
24, . . .	77.25	–	1.64	3.21
May 4,* . . .	88.00	–	5.40	0.05
11, . . .	105.75	–	2.57	7.14
18, . . .	117.75	–	–	12.00
25, . . .	125.75	3.57	–	11.14
June 1, . . .	137.50	12.14	–	10.00
8, . . .	152.00	8.72	–	9.57
15, . . .	163.75	9.58	–	10.00
22, . . .	173.25	10.86	–	10.00
26, . . .	175.50	16.50	–	9.50
Total gain in 70 days,	101.50	10.23	–	8.26
Average daily gain, .	1.45	–	–	–

* Ten-day period.

CALF 3.

April 21, ...	53.25	–	–	–
May 4,* . . .	59.00	–	3.53	1.13
11, ...	73.25	–	3.43	5.30
18, ...	84.25	–	–	11.00
25, ...	92.25	–	–	11.43
June 1, ...	99.25	–	–	12.00
8, ...	109.50	7.58	–	10.71
15, ...	118.25	7.14	–	10.00
22, ...	125.25	6.86	–	10.00
29, ...	137.25	10.86	–	9.71
July 6, ...	148.00	12.00	–	10.00
13, ...	155.50	15.72	–	10.00
21, ...	160.25	13.00	–	11.75
Total gain in 92 days,	107.00	10.45	–	8.78
Average daily gain, .	1.16	–	–	–

* Fifteen-day period.

CALF 4.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	Average Daily Amount of Grain consumed (Ounces).	AVERAGE DAILY AMOUNT OF MILK CONSUMED. Fresh Milk (Quarts).	Skim-milk (Quarts).
June 10, ...	70.75	–	–	–
16, ...	78.75	–	3.14	3.14
23, ...	88.25	–	1.43	8.00
30, ...	101.25	–	–	10.57
July 7, ...	118.75	–	–	9.00
14, ...	127.00	7.43	–	9.71
21, ...	142.00	8.14	–	10.00
28, ...	152.00	8.57	–	10.00
Aug. 4, ...	154.50	7.43	–	11.14
11, ...	163.25	8.57	–	12.00
18, ...	175.00	10.00	–	12.00
25, ...	180.75	11.14	–	12.00
Sept. 4, ...	185.00	12.60	–	12.00
Total gain in 87 days,	114.25	9.23	–	9.96
Average daily gain, .	1.31	–	–	–

CALF 5.

July 22, ...	70.00	–	–	–
28, ...	83.50	–	4.74	4.14
Aug. 4, ...	96.00	–	–	10.86
11, ...	108.75	–	–	12.00
18, ...	112.50	–	–	10.71
25, ...	122.75	3.14	–	9.30
Sept. 1, ...	128.25	7.71	–	10.50
8, ...	141.50	–	–	12.86
15, ...	157.25	–	–	17.71
22, ...	178.50	–	–	20.00
Oct. 1, ...	189.25	–	–	20.00
Total gain in 72 days,	119.25	–	–	12.81
Average daily gain, .	1.63	–	–	–

Calf 6.

Weekly Periods (Dates).	Weight of Animal (Pounds).	Average Daily Amount of Grain consumed (Ounces).	Average Daily Amount of Milk consumed.	
			Fresh Milk (Quarts).	Skim-milk (Quarts).
Sept. 29, ...	68.00	–	–	–
Oct. 5, ...	83.75	–	3.71	3.71
12, ...	95.25	–	2.00	8.00
19, ...	110.50	–	–	11.29
26, ...	126.50	–	–	13.71
Nov. 2, ...	137.00	–	–	13.71
9, ...	152.50	–	–	14.86
19, ...	169.50	–	–	16.00
Total gain in 52 days,	101.50	–	–	11.61
Average daily gain, .	1.95	–	–	–

Calf 7.

Oct. 1, ...	74.25	–	–	–
7, ...	83.75	–	4.00	4.57
14, ...	95.75	–	0.86	9.43
21, ...	108.50	–	–	11.71
28, ...	120.50	–	–	13.14
Nov. 4, ...	126.50	–	–	11.68
11, ...	141.50	–	–	12.29
18, ...	155.50	–	–	14.00
24, ...	157.25	–	–	13.67
Total gain in 55 days,	83.00	–	–	11.31
Average daily gain, .	1.51	–	–	–

Tables giving Detailed Record of Each Calf.

Calf 1.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Corn Meal (Ounces).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	April 4 to April 21,	10.00	156.00	120.00	1:2.5 to 1:3.5	99.50	132.25	1.82	3.32
II.	April 22 to May 5,	-	150.00	227.00		132.25	160.25	2.00	3.00
III.	May 6 to May 27,	-	183.00	536.00		160.25	177.00	0.76	7.22

Total Amount of Feed consumed from April 4 to May 27, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
10.00 quarts whole milk, . . .	2.97	$0 30	$0 02
489.00 quarts skim-milk, ...	100.72	2 20	0 81
55.20 pounds corn meal, ...	43.80	0 63	0 10
	147.49	$3 13	$0 93

Live weight of the animal at the beginning of the experiment,	99.50 lbs.
Live weight of the animal at the end of the experiment, .	177.00 "
Live weight gained during the experiment, ...	77.50 "
Dressed weight of the animal, ...	100.00 "
Loss in weight by dressing, 43.50 per cent., ...	77.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.93 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.37 "
Total cost of feed per pound of live weight gained, . .	4.04 cts.
Net cost of feed per pound of live weight gained, . .	3.00 "

CALF 2.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	Corn Meal (Ounces).	Gluten Feed (Ounces).	Old-process Linseed Meal (Ounces).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	Apr. 18 to May 12,	83.50	90.50	–	–	–	1:2.00 to 1:3.00	74.00	105.75	1.27	9.17
II.	May 13 to June 2,	–	230.00	130.00	–	–		105.75	137.50	1.51	3.55
III.	June 3 to June 16,	–	137.00	–	69.00	69.00		137.50	163.75	1.87	2.73
IV.	June 17 to June 26,	–	98.00	–	66.00	66.00		163.75	175.50	1.17	4.56

Total Amount of Feed consumed from April 18 to June 26, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
83.50 quarts whole milk,	24.81	$2 51	$0 15
555.50 quarts skim-milk,	116.01	2 50	0 93
8.10 pounds corn meal,	6.94	0 09	0 02
8.44 pounds Buffalo gluten feed,	7.65	0 08	0 04
8.44 pounds old-process linseed meal,	7.49	0 11	0 06
	162.90	$5 29	$1 20

Live weight of the animal at the beginning of the experiment,	74.00 lbs.
Live weight of the animal at the end of the experiment,	175.50 "
Live weight gained during the experiment,	101.50 "
Dressed weight of the animal,	92.00 "
Loss in weight by dressing, 48 per cent.,	83.50 "
Pounds of dry matter to produce 1 pound of live weight,	1.60 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.04 "
Total cost of feed per pound of live weight gained,	5.21 cts.
Net cost of feed per pound of live weight gained,	4.02 "

CALF 3.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Corn Meal (Ounces).	Gluten Feed (Ounces).	Old-process Linseed Meal (Ounces).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	Apr. 21 to June 2,	77.00	294.00	10.00	–	–	1:2.00 to 1:2.50	53.28	99.25	1.10	7.89
II.	June 3 to June 30,	–	281.00	–	113.50	113.50		99.25	137.25	1.36	3.76
III.	July 1 to July 21,	–	224.00	–	144.00	144.00		137.25	160.25	1.10	5.28

Total Amount of Feed consumed from April 21 to July 21, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
77.00 quarts whole milk,	22.88	$2 31	$0 14
799.00 quarts skim-milk,	166.87	3 59	1 34
0.62 pounds corn meal,	0.53	0 01	–
16.10 pounds Buffalo gluten feed,	14.59	0 16	0 08
16.10 pounds old-process linseed meal,	14.30	0 21	0 12
	219.17	$6 28	$1 67

Live weight of the animal at the beginning of the experiment,	53.25 lbs.
Live weight of the animal at the end of the experiment,	160.25 "
Live weight gained during the experiment,	107.00 "
Dressed weight of the animal,	–
Loss in weight by dressing,	–
Pounds of dry matter to produce 1 pound of live weight,	2.03 "
Pounds of dry matter to produce 1 pound of dressed weight,	–
Total cost of feed per pound of live weight gained,	5.87 cts.
Net cost of feed per pound of live weight gained,	4.30 "

CALF 4.

Feeding Periods.	DATE OF PERIODS.	Whole Milk (Quarts).	Skim-milk (Quarts).	Wheat Flour (Ounces).	Old-process Linseed Meal (Ounces).	Gluten Feed (Ounces).	Wheat Middlings (Ounces).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	June 10 to June 30,	32.00	152.00	-	-	-	-	1 : 2.00 to 1 : 2.5	70.75	101.75	1.48	5.30
II.	July 1 to July 14,	-	131.00	44.00	-	-	-		101.75	127.00	1.80	2.51
III.	July 15 to Aug. 11,	-	302.00	61.00	30.00	76.00	62.00		127.00	163.25	2.13	4.37
IV.	Aug. 12 to Sept. 4,	-	288.00	-	-	137.00	137.00		163.25	185.00	0.90	7.14

Total Amount of Feed consumed from June 10 to Sept. 4, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
32.00 quarts whole milk, . . .	9.49	$0 96	$0 08
873.00 quarts skim-milk, ...	180.18	3 85	1 43
6.56 pounds wheat flour, . . .	5.73	0 13	0 02
1.90 pounds old-process linseed meal, .	1.69	0 02	0 01
13.31 pounds Buffalo gluten feed, . .	12.06	0 13	0 06
12.44 pounds wheat middlings, . .	11.06	0 13	0 05
	220.21	$5 22	$1 65

Live weight of the animal at the beginning of the experiment, 70.75 lbs.
Live weight of the animal at the end of the experiment, . 185.00 "
Live weight gained during the experiment, ... 114.25 "
Dressed weight of the animal, ... 101.00 "
Loss in weight by dressing, 45 per cent., ... 84.00 "
Pounds of dry matter to produce 1 pound of live weight, . 1.93 "
Pounds of dry matter to produce 1 pound of dressed weight, 3.51 "
Total cost of feed per pound of live weight gained, . . 4.57 cts.
Net cost of feed per pound of live weight gained, . . 3.12 "

CALF 5.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Gluten Feed (Ounces).	Wheat Middlings (Ounces).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	July 22 to Aug. 4.	27.00	105.00	–	–	1 : 2.00	70.00	96.00	1.86	4.83
II.	Aug. 5 to Sept. 1,	–	297.50	38.00	38.00		96.00	128.25	1.12	4.34
III.	Sept. 2 to Sept. 15,	–	214.00	–	–		128.25	157.25	2.09	3.32
IV.	Sept.16 to Oct. 1,	–	320.00	–	–		157.25	189.25	2.00	4.50

Total Amount of Feed consumed from July 22 to Oct. 1, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
27.00 quarts whole milk, ...	8.02	$0 81	$0 05
936.50 quarts skim-milk, ...	195.58	4 21	1 57
2.40 pounds Buffalo gluten feed, . .	2.18	0 02	0 01
2.40 pounds wheat middlings, . .	2.13	0 03	0 01
	207.91	$5 07	$1 64

Live weight of the animal at the beginning of the experiment,	70.00 lbs.
Live weight of the animal at the end of the experiment, .	189.25 "
Live weight gained during the experiment, ...	119.25 "
Dressed weight of the animal, ...	108.00 "
Loss in weight by dressing, 43 per cent., ...	81.25 "
Pounds of dry matter to produce 1 pound of live weight, .	1.74 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.67 "
Total cost of feed per pound of live weight gained, . .	4.25 cts.
Net cost of feed per pound of live weight gained, . .	3.72 "

CALF 6.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	Sept. 29 to Oct. 13, .	40.00	92.00	1:2.00 to 1:2.25	68.00	95.25	1.82	5.92
II.	Oct. 14 to Oct. 27, .	-	179.00		95.25	125.50	1.68	2.66
III.	Oct. 28 to Nov. 19, .	-	346.00		125.50	166.50	1.78	3.79

Total Amount of Feed consumed from Sept. 29 to Nov. 19, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
40.00 quarts whole milk, . . .	11.89	$1 20	$0 07
617.00 quarts skim-milk, ...	128.86	2 77	1 04
	140.74	$3 97	$1 11

Live weight of the animal at the beginning of the experiment,	68.00 lbs
Live weight of the animal at the end of the experiment, .	166.50 "
Live weight gained during the experiment, ...	98.50 "
Dressed weight of the animal, ...	90.00 "
Loss in weight by dressing, 45 per cent., ...	46.50 "
Pounds of dry matter to produce 1 pound of live weight, .	1.43 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.37 "
Total cost of feed per pound of live weight gained, . .	4.03 cts.
Net cost of feed per pound of live weight gained, . .	2.90 "

CALF 7.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Cod Liver Oil (Ounces).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain. (Pounds).	Cost of Feed per Pound of Live Weight Gained (Cents).
I.	Oct. 1 to Oct. 13, .	34.00	86.00	–	1 : 2.00	74.25	95.75	1.65	6.62
II.	Oct. 14 to Oct. 27, .	–	174.00	25.00		95.75	120.50	1.77	5.59
III.	Oct. 28 to Nov. 24, .	–	361.00	–		120.50	157.25	1.31	4.39

Total Amount of Feed consumed from Oct. 1 to Nov. 24, 1893.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
34.00 quarts whole milk, ...	10.24	$1 02	$0 06
621.00 quarts skim-milk, ...	129.69	2 79	1 04
25.00 ounces cod liver oil, ...	1.56	0 60	–
	141.49	$4 41	$1 10

Live weight of the animal at the beginning of the experiment,	74.25 lbs.
Live weight of the animal at the end of the experiment, .	157.25 "
Live weight gained during the experiment, ...	83.00 "
Dressed weight of the animal, ...	91.00 "
Loss in weight by dressing, 42 per cent., ...	66.25 "
Pounds of dry matter to produce 1 pound of live weight, .	1.70 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.94 "
Total cost of feed per pound of live weight gained, . .	5.31 cts.
Net cost of feed per pound of live weight gained, . .	3.99 "

Local Market Cost per Ton of the Various Articles of Fodder used.

Corn meal, ...	$23 00
Buffalo gluten feed, ...	20 00
Old-process linseed meal, ...	26 00
Wheat middlings, ...	22 00
Skim-milk, per gallon, ...	1.8 cts.
Whole milk, per quart, ...	3.0 cts.
Wheat flour, per pound, ...	2.0 cts.
Cod liver oil, per gallon, ...	$3 00

Analyses of Fodder Articles used.

FODDER ANALYSES.	Corn Meal.	Buffalo Gluten Feed.	Old-process Linseed Meal.	Wheat Middlings.	Skim-milk.	Whole Milk.
Moisture at 100° C.,	14.24*	9.38	11.21	11.12	90.42	86.18
Dry matter,	85.76	90.62	88.79	88.88	9.58	13.82
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	1.63	0.98	6.97	3.48	8.14	5.35
" cellulose,	1.93	8.06	8.21	3.97	-	-
" fat,	3.27	14.47	8.27	5.92	2.61	33.43
" protein,	10.26	25.79	36.75	20.07	35.23	25.33
Non-nitrogenous extract matter,	82.91	50.70	39.80	66.56	54.02	35.89
	100.00	100.00	100.00	100.00	100.00	100.00

* Moisture, as fed to calf 1, 20.67.

Fertilizing Constituents.

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5½ cents, per pound.]

FERTILIZER ANALYSES.	Wheat Flour.	Corn Meal.	Buffalo Gluten Feed.	Old-process Linseed Meal.	Wheat Middlings.	Skim-milk.	Whole Milk.
Moisture,	12.60	14.24	9.38	11.21	11.12	90.42	86.18
Nitrogen,	1.90	1.41	3.73	5.22	2.84	0.52	0.56
Phosphoric acid,	0.24	0.70	0.46	1.78	1.54	0.18	0.19
Potassium oxide,	0.18	0.40	0.10	1.21	0.87	0.19	0.17
Value per 2,000 pounds,	$7 09	$6 08	$13 63	$21 38	$12 44	$2 21	$2 34
Manurial value obtainable,*	4 96	4 26	9 54	14 97	8 71	1 55	1 64

* Allowing thirty per cent. of the fertilizing constituents to be retained in the system of the growing animal.

VI.

DIGESTION EXPERIMENTS WITH SHEEP.

By J. B. Lindsey.*

Experiments to determine the digestibility of various foods have been conducted quite extensively in Germany for the last twenty-five years, and during the past ten years many experiments of a similar nature have been carried out by various experiment stations in the United States.

Value of Digestion Experiments.

1. A food is valuable as a source of nourishment only in so far as its various constituents can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having from ten to fifteen per cent. more digestible matter, would prove the more valuable fodder.

For one to form an intelligent opinion as to the value of different fodder stuffs, the amount of digestible matter they contain must be known.

2. It has been demonstrated that, in order to keep a milch cow of one thousand pounds live weight in good condition and to enable her to give the largest quantity of milk, she needs approximately 2.5 to 3 pounds of digestible protein, .5 pound of digestible fat and 12.5 pounds of digestible carbohydrates daily.

In combining the various foods so as to furnish approximately such a ration, it is absolutely essential that one should know the various percentages of the different digestible constituents they contain.

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* It is desired to acknowledge the efficient and painstaking services rendered by Messrs. E B. Holland, C. H. Johnson, C. H. Jones and H. D. Haskins. Mr. Johnson assisted in the stable and laboratory, Messrs. Jones and Haskins in the laboratory, and Mr. Holland in the laboratory and in collating the data.

What the Excreta of an Animal is.

The fæces are nothing more than the undigested portion of the food. It is the portion that has resisted the action of the various secretions of the stomach and digestive fluids and bacteria of the intestines, and is consequently excreted by the animal as so much worthless material. The urine is entirely distinct from the fæces. It contains the water, and the end products of the digestion of the nitrogenous portion of the food, — the urea and hippuric acid, — which have been removed from the blood by the kidneys. It also contains about one-third of the phosphoric acid and nearly all of the alkalies of the food consumed that have not been retained in the animal's system, and small quantities of other materials that it is unnecessary to consider in this connection.

How the Digestible Matter of a Food is Determined.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

DESCRIPTION OF THE PRESENT EXPERIMENT.

It has been found that ruminants — cows, steers, sheep, etc. — digest very nearly equal quantities of the same foods.* Sheep being easier to work with, the experiments here reported were conducted with these animals. The animals were grade Southdown wethers. Nos. I. and II. were three-year-olds, and Nos. III. and IV. yearlings. They weighed about one hundred pounds each.

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* See exception to this in Pennsylvania Station Report, page 46, 1890. This experiment showed that sheep digested fourteen to fifteen per cent. less dry matter, cellulose and nitrogen-free extract matter, and only one-half as much protein, as did steers, in case of ensilage made from Burrell and Whitman corn.

The animals were fed a certain weighed quantity of food for fourteen days. The first seven days were regarded as a preliminary period. This preliminary time allowed the animals to become accustomed to the new feed, and to eliminate all the previous foods from the intestines. The animals were fed a so-called maintenance ration, which is a quantity of food sufficient to keep them in good health and condition, without either gaining or losing in weight. During the last seven days the fæces were carefully collected and accurately weighed, and an aliquot part — one-tenth — dried daily and preserved for analysis.

The temperature of the barn, amount of water drank and the amount and specific gravity of the urine were also carefully noted.

The food fed was weighed out in advance for the entire period, carefully sampled, moisture determinations made at once, and a sample reserved for complete analysis. The animals were weighed at the beginning and end of each quantitative period.

Method employed in Collecting the Fæces and Urine.

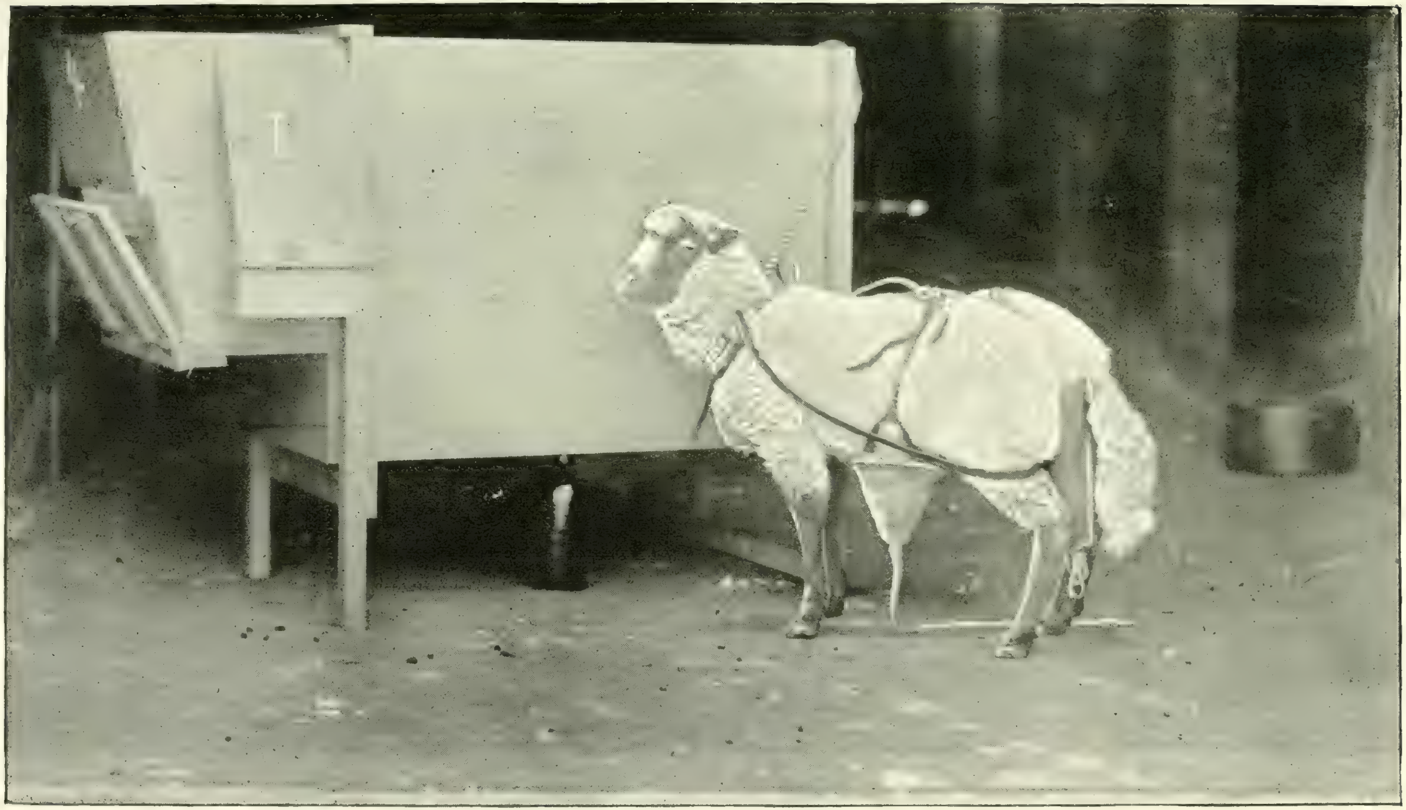
The cut presented in connection with this experiment gives a clear idea of the arrangement. The animals were confined in wooden stalls, forty-two inches long by twenty-four inches wide, raised fourteen inches above the barn floor.

By means of a light leather harness a rubber bag is securely attached behind, to collect the fæces, and a rubber funnel conducts the urine down into a bottle placed beneath the stall. The animal stands upon cushions of about one and one-half inches in thickness.

Water is before the animal at all times, contained in a galvanized-iron pan, placed on a bracket, as in figure I.

The food is given in a large zinc pan, which is made to fit tightly into the stall and can be removed at will (see just below figure 4).

The fæces were collected twice daily in large glass-stoppered bottles, and every morning one-tenth of the twenty-four hours' collection was dried and preserved.



Sheep Harnessed for Digestion Experiments at the Massachusetts State Experiment Station, 1893.

Analytical Methods.

At the close of the period these daily "tenths," after being weighed in an approximately air-dry condition, were mixed, and after being once run through a coarse grinding mill to break the pellets, duplicate dry matter determinations were made and the material then ground fine for a complete analysis.

Moisture determinations were made in an air bath at a temperature of 102° to 103° C., about seven grams of substance being taken. Total nitrogen was determined by the Kjeldahl method. The fat was extracted with anhydrous ether. The methods for the determination of ash and cellulose were those described by the Association of Official Agricultural Chemists.

The Feeds tested.

The object in making these experiments has been to obtain a knowledge of the comparative digestibility of the various concentrated by-products, so called, that are being so extensively offered for sale in our Massachusetts markets. The digestibility of hay of mixed grasses grown upon the station grounds was first determined, and then a certain amount of the concentrated food was substituted for an equal amount of the hay, as the data that is to follow will show.

Brief Description of the Feeds tested.

Hay of Mixed Grasses.

The hay is intended to be a fair average of that grown upon the station grounds. It was harvested the latter part of June, when the various grasses were in blossom. The grasses composing the same were principally herd's grass, red top, Kentucky blue-grass, meadow fescue, sweet-scented vernal grass and a fair sprinkling of clover.

Buffalo Gluten Feed.

This is a by-product in the manufacture of starch from corn. The starch is separated from the yellow or albuminous

part of the grain by means of water. The hulls and germs are separated by screening. After the starch is removed the yellow or flinty portion is mixed with the germs and hulls. The mixture is kiln dried and partially ground.

New and Old Process Linseed Meals.

Linseed meal is that part of the seed of the flax remaining after the oil has been removed. In case of the new-process meal the fat is more thoroughly removed. Both products were in good mechanical condition, and after a few days the animals consumed them eagerly.

Dried Brewers' Grains.

This is that part of the barley remaining after the starch has been largely removed by sprouting and fermentation. In order that the grains can be transported they are eventually kiln dried. The sample was in excellent condition.

Corn Cobs.

These cobs were ground as fine as was practicable by our local miller. When fed they were mixed with about one-half their weight of linseed meal.

Spring and Winter Wheat Brans.

These brans were in good condition, and, so far as chemical analysis indicates, had approximately the same composition.

Wheat Middlings.

This was a very good quality of middlings, being ground as fine as flour. It was quite light in color.

The table of analysis of the above feeds will be found a few pages farther on.

A SINGLE ILLUSTRATION

Showing how the digestibility of a fodder is determined. Solid manure equals the undigested part of food.

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams).
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.69
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

A detailed account of the various digestion experiments made at this station during the past year will be found in the pages following. In the table below is presented a *résumé* of the results obtained : —

Results of the Experiment.

Digestibility of the Foods.

Kind of Food.	Number of Different Samples.	Number of Experiments.	Number of Animals.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of mixed grasses (*a*),	1	1	3	61	64	51	63	63
Hay of mixed grasses (*b*),	1	1	4	56	57	47	57	58
Average both samples,	2	2	7	58	60	49	60	60
Buffalo gluten feed,	1	1	2	78	43	81	85	81
New-process linseed meal,	1	1	2	81	61	91	87	86
Old-process linseed meal,	1	1	3	79	57	89	89	78
Corn cobs,	1	1	2	59	65	50	17	60
Dried brewers' grains,	1	1	2	62	53	91	79	59
Spring wheat bran,	1	1	2	63	24	76	80	70
Winter wheat bran,	1	1	1	66	56	61	79	70
Wheat middlings,*	1	1	2	83	36	85	85	88

* Very fine and quite light colored.

Brief Remarks on the Above Results.

The Buffalo gluten feed proves to be quite digestible. The fat has approximately the same degree of digestibility as in corn meal, while the protein appears even more digestible. The cellulose and extract matter, however, fall somewhat below those of the corn meal, as would be expected.

The new and old process linseed meals compare very favorably with each other, only slight differences being observed.

Corn cobs appear fully as digestible as a good quality of English hay, with the exception of the protein, of which they contain but a small amount.

Dried brewers' grains and wheat bran approach each other very closely in the amount of dry matter digested. The digestibility of the protein in both cases appears practically identical. The fat in the brewers' grains appears rather more digestible than that in the bran, while in case of the extract matter the opposite is the result.

Winter wheat bran generally costs about two dollars per ton more in the retail markets than does the spring bran, and it was our object to see if analysis and digestibility warranted this extra price. So far as composition is concerned, the two brans are practically alike. We regret that at present positive conclusions cannot be drawn from the digestion experiments. In case of the winter wheat bran, through an unfortunate circumstance only the results obtained with one sheep can be presented. From the results offered it will be noticed that the protein and extract matter have almost identical coefficients, but the fat appears rather more digestible in the spring bran, and the cellulose more digestible in the winter bran. As these two latter ingredients are of minor importance, however, because of their comparative small absolute percentage when compared with the protein and extract matter, the comparative value of the two brans would not be seriously affected. Therefore the results thus far would indicate no material difference between the two brans. The experiment will be repeated, however, at an early date, and as soon as more decisive results are obtained they will be published.

The finer grade of wheat middlings coincides very closely in digestibility with Buffalo gluten feed. The chief difference between the two feeds is that the Buffalo gluten feed contains about four per cent. more protein than the wheat middlings.

Details of the Experiment.

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Manure Excreted.

Sheep I.

Periods.	Hay.	Buffalo Gluten Feed.	New-process Linseed Meal.	Old-process Linseed Meal.	Corn Cobs.	Dried Brewers' Grains.	Spring Wheat Bran.	Wheat Middlings.	Waste.	Manure.
III., . . .	85.04	-	-	-	-	-	-	-	-	91.51
VI., . . .	85.34	-	88.10	-	87.95	-	-	-	-	92.47
VII., . .	86.60	-	-	-	-	89.68	-	-	-	95.34
X., . . .	87.24	-	-	-	-	-	-	86.94	-	94.39

Sheep II.

Periods.	Hay.	Buffalo Gluten Feed.	New-process Linseed Meal.	Old-process Linseed Meal.	Corn Cobs.	Dried Brewers' Grains.	Spring Wheat Bran.	Wheat Middlings.	Waste.	Manure.
I., . . .	84.24	-	-	-	-	-	-	-	79.33	92.07
II., . . .	83.51	90.59	-	-	-	-	-	-	77.67	88.78
III., . . .	85.04	-	-	-	-	-	-	-	-	91.56
IV., . . .	87.73	-	88.28	-	-	-	-	-	-	94.53
V., . . .	86.23	-	-	87.28	-	-	-	-	-	94.79
VI., . . .	85.34	-	88.10	-	87.89	-	-	-	-	91.40
VII., . .	86.60	-	-	-	-	89.68	-	-	-	93.36
VIII., . .	87.24	-	-	-	-	-	87.31	-	-	95.12

Sheep III.

Periods.	Hay.	Buffalo Gluten Feed.	New-process Linseed Meal.	Old-process Linseed Meal.	Spring Wheat Bran.	Winter Wheat Bran.	Wheat Middlings.	Waste.	Manure.
I., ...	85.50	-	-	-	-	-	-	74.28	92.75
III., ...	85.04	-	-	-	-	-	-	-	91.33
IV., ...	87.73	-	88.28	-	-	-	-	-	94.10
V., ...	86.23	-	-	87.28	-	-	-	-	94.67
VIII., ...	87.24	-	-	-	87.31	-	-	-	95.04

Sheep IV.

Periods.	Hay.	Buffalo Gluten Feed.	New-process Linseed Meal.	Old-process Linseed Meal.	Spring Wheat Bran.	Winter Wheat Bran.	Wheat Middlings.	Waste.	Manure.
I., ...	85.50	-	-	-	-	-	-	-	92.60
II., ...	88.05	90.00	-	-	-	-	-	-	91.00
III., ...	85.04	-	-	-	-	-	-	-	90.87
V., ...	87.73	-	-	88.00	-	-	-	-	94.58
IX., ...	86.23	-	-	-	-	86.49	-	-	95.60
X., ...	87.24	-	-	-	-	-	86.94	-	95.13

Composition of Feed Stuffs.

[Dry Matter.]

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay (*a*),	6.58	30.33	3.48	11.10	48.51
Hay (*b*),	7.83	32.74	3.08	10.79	45.56
Buffalo gluten feed,	0.78	8.38	14.29	26.35	50.20
New-process linseed meal,	5.84	8.59	4.01	40.40	41.16
Old-process linseed meal,	6.97	8.21	8.27	36.75	39.80
Corn cobs,	1.92	27.17	1.28	3.86	65.77
Dried brewers' grains,	3.59	14.52	7.81	22.99	51.09
Spring wheat bran,	6.13	11.48	5.40	17.60	59.39
Winter wheat bran,	6.24	9.32	4.57	17.04	62.83
Wheat middlings,	1.50	3.53	6.10	21.06	67.81
Waste from Sheep II.,*	15.07	27.78	2.97	11.84	42.34
Waste from Sheep II.,†	12.85	28.47	2.93	11.28	44.48
Waste from Sheep III.,*	14.68	18.02	3.79	14.98	48.53

* Period I. † Period II.

Composition of the Fæces.

[Dry Matter.]

SHEEP I.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period III.					
Hay,	11.13	31.66	3.79	10.25	43.17
Period VI.					
Hay, new-process linseed meal and corn cob,	8.28	27.53	2.62	11.37	50.20
Period VII.					
Hay and dried brewers' grains,	11.99	25.52	2.82	11.55	48.12
Period X.					
Hay and wheat middlings,	11.80	27.89	3.75	11.83	44.73

SHEEP II.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period I.					
Hay,	11.99	28.72	3.81	10.35	45.13
Period II.					
Hay and Buffalo gluten feed,	11.39	26.64	5.49	11.57	44.91

SHEEP II. — *Concluded.*

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period III.					
Hay,	10.33	32.16	3.62	10.06	43.83
Period IV.					
Hay and new-process linseed meal,	12.02	30.50	3.35	12.81	41.32
Period V.					
Hay and old-process linseed meal,	12.29	30.05	3.45	12.00	42.21
Period VI.					
Hay, new-process linseed meal and corn cob,	8.77	26.63	2.60	11.07	50.93
Period VII.					
Hay and dried brewers' grains,	11.30	26.68	3.02	10.66	48.34
Period VIII.					
Hay and spring-wheat bran,	11.57	29.65	3.58	10.16	45.04

SHEEP III.

Period I.					
Hay,	10.30	27.48	4.83	10.62	46.77
Period III.					
Hay,	11.28	31.47	3.65	10.69	42.91
Period IV.					
Hay and new-process linseed meal,	12.68	28.89	3.41	13.06	41.96
Period V.					
Hay and old-process linseed meal,	12.32	28.84	4.11	11.13	43.60
Period VIII.					
Hay and spring-wheat bran,	13.46	29.01	3.62	10.10	43.81

SHEEP IV.

Period I.					
Hay,	10.99	27.72	4.50	10.43	46.36
Period II.					
Hay and Buffalo gluten feed,	9.21	26.90	6.22	12.42	45.25
Period III.					
Hay,	11.50	31.17	3.68	10.50	43.15
Period V.					
Hay and old-process linseed meal,	11.92	28.31	3.80	12.56	43.41
Period IX.					
Hay and winter wheat bran,	12.80	25.92	4.15	10.61	46.52
Period X.					
Hay and wheat middlings,	12.33	28.88	4.25	11.54	43.00

Tables showing Food fed and Water drank Daily, the Daily Amount of Manure and Urine excreted and the Temperature of the Stables.

PERIOD I. SHEEP II.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
March 31, . .	45.0	900	90.0	34.30	1,106	1.0303	1,915
April 1, . .	43.0	882	88.2	34.61	1,102	1.0331	1,855
2, . .	46.0	693	69.3	27.04	1,017	1.0337	1,820
3, . .	36.0	869	86.9	33.69	977	1.0356	1,650
4, . .	45.0	711	71.1	28.84	1,071	1.0342	1,532
5, . .	50.0	776	77.6	31.54	1,054	1.0340	1,780
6, . .	44.0	817	81.7	34.02	1,003	1.0358	1,480
Averages, .	44.1	807	80.7	32.06	1,047	1.0338	1,719

Weight of animal at beginning of period, ... 110.75 lbs.
Weight of animal at end of period, ... 110.75 "

PERIOD I. SHEEP III.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
May 9, . .	64.0	918	91.8	32.29	1,033	1.0301	1,753
10, . .	69.5	817	81.7	31.98	1,073	1.0324	2,350
11, . .	72.5	806	80.6	32.59	893	1.0340	2,645
12, . .	72.5	757	75.7	30.97	1,108	1.0291	3,153
13, . .	60.0	653	65.3	26.78	917	1.0344	2,725
14, . .	64.0	719	71.9	29.15	1,104	1.0306	1,675
15, . .	69.5	846	84.6	32.45	878	1.0321	1,978
Averages, .	67.4	788	78.8	30.89	1,009	1.0318	2,326

Weight of animal at beginning of period, ... 104.50 lbs.
Weight of animal at end of period, ... 105.25 "

* The amount of urine here reported includes the water used to wash the inside of the rubber funnel. This amounted to 194.3 grams daily.

Period I. Sheep IV.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
May 9, . .	64.0	783	78.3	30.04	1,319	1.0239	1,617
10, . .	69.5	928	92.8	33.59	1,282	1.0266	2,332
11, . .	72.5	852	85.2	32.74	1,183	1.0272	2,395
12, . .	72.5	818	81.8	31.92	1,613	1.0231	1,438
13, . .	60.0	792	79.2	32.93	1,343	1.0259	2,415
14, . .	64.0	753	75.3	30.41	1,291	1.0262	1,850
15, . .	69.5	803	80.3	32.72	1,429	1.0268	2,155
Averages, .	67.4	818	81.8	32.05	1,351	1.0257	2,027

Weight of animal at beginning of period, ... 102.25 lbs.
Weight of animal at end of period, ... 101.50 "

Period II. Sheep II.

[Fodder consumed daily: 600 grams hay, 300 grams Buffalo gluten feed and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
April 15, . .	44.5	897	89.7	35.07	1,141	1.0310	1,950
16, . .	49.0	781	78.1	31.26	1,004	1.0254	1,763
17, . .	43.0	807	80.7	30.33	–	–	1,787
18, . .	46.0	704	70.4	24.43	901	1.0323	1,905
19, . .	46.5	724	72.4	27.67	1,180	1.0257	2,062
20, . .	43.5	709	70.9	26.77	1,150	1.0270	1,726
Averages, .	45.4	770	77.0	29.26	1,075	1.0283	1,866

Weight of animal at beginning of period, ... 111.00 lbs.
Weight of animal at end of period, ... 110.75 "

* See foot-note on page 157.

PERIOD II. SHEEP IV.

[Fodder consumed daily: 600 grams hay, 250 grams Buffalo gluten feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
June 10, . .	79.5	833	83.3	26.45	–	–	–
11, . .	82.0	781	78.1	26.51	1,309	1.0195	3,316
12, . .	75.5	753	75.3	26.85	1,470	1.0125	3,350
13, . .	72.5	629	62.9	26.79	1,000	1.0260	2,541
14, . .	77.0	689	68.9	27.82	–	–	2,193
15, . .	80.0	743	74.3	28.95	1,512	1.0183	3,154
Averages, .	77.8	738	73.8	27.23	1,323	1.0191	2,911

Weight of animal at beginning of period, ... 102.50 lbs.
Weight of animal at end of period, ... 104.50 "

PERIOD III. SHEEP I.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
September 25, .	60	975.0	97.5	35.69	1,548	1.0190	2,248
26, .	56	974.0	97.4	39.06	1,831	–	2,435
27, .	50	867.0	86.7	35.88	1,451	1.0229	1,975
28, .	58	861.0	86.1	36.86	1,716	1.0191	2,395
29, .	52	823.0	82.3	35.47	1,816	1.0209	1,932
30, .	57	869.0	86.9	37.03	1,982	1.0191	2,406
October 1, .	55	863.0	86.3	38.74	1,773	1.0180	2,083
Averages, .	57	890.3	89.03	36.96	1,731	1.0132	2,211

Weight of animal at beginning of period, ... 94.00 lbs.
Weight of animal at end of period, ... 92.75 "

* See foot-note on page 157.

PERIOD III. SHEEP II.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
September 19, .	60	770.0	77.00	37.57	1,165	1.0304	1,740
20, .	70	745.0	74.50	35.89	1,114	1.0295	1,775
21, .	61	832.0	83.20	39.80	–	–	1,279
22, .	58	867.0	86.70	30.92	–	–	1,525
23, .	60	734.0	73.40	34.58	1,314	1.0285	1,510
24, .	62	775.0	77.50	36.60	1,135	1.0318	–
25, .	60	824.0	82.40	38.35	1,201	1.0286	–
Averages, .	62	792.4	79.24	37.53	1,186	1.0297	1,566

Weight of animal at beginning of period, ... 98.75 lbs.
Weight of animal at end of period, ... 98.50 "

PERIOD III. SHEEP III.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
September 19, .	60	753.0	75.3	37.72	943	1.0344	1,077
20, .	70	764.0	76.4	37.59	896	1.0342	1,685
21, .	61	798.0	79.8	38.55	916	1.0333	1,875
22, .	58	896.0	89.6	38.38	1,092	1.0314	1,687
23, .	60	816.0	81.6	35.84	1,010	1.0330	1,603
24, .	62	787.0	78.7	32.46	976	1.0329	–
25, .	60	857.0	85.7	39.54	1,090	1.0335	–
Averages, .	62	810.1	81.01	37.15	989	1.0333	1,585

Weight of animal at beginning of period, ... 94 lbs.
Weight of animal at end of period, ... 95 "

* See foot-note on page 157.

Period III. Sheep IV.

[Fodder consumed daily: 900 grams hay and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
September 19, .	60	949.0	94.9	42.23	1,198	1.0291	1,835
20, .	70	782.0	78.2	35.68	1,375	1.0262	1,930
21, .	61	827.0	82.7	37.98	1,334	–	1,806
22, .	58	759.0	75.9	35.61	1,328	1.0259	1,653
23, .	60	722.0	72.2	34.11	1,321	1.0252	1,603
24, .	62	794.0	79.4	38.32	1,248	1.0270	–
25, .	60	745.0	74.5	36.31	1,555	1.0201	–
Averages, .	62	796.9	79.7	37.18	1,337	1.0256	1,765

Weight of animal at beginning of period, ... 102.00 lbs.
Weight of animal at end of period, ... 102.25 "

Period IV. Sheep II.

[Fodder consumed daily: 600 grams hay, 250 grams new-process linseed meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 6, .	47.0	742	74.2	31.25	1,141	1.0330	1,295
7, .	46.0	743	74.3	29.34	1,156	1.0337	1,454
8, .	38.0	771	77.1	30.19	1,025	1.0359	1,481
9, .	47.5	825	82.5	30.07	1,001	1.0354	1,320
10, .	43.5	819	81.9	29.24	954	1.0387	1,254
11, .	44.5	819	81.9	28.02	943	1.0379	1,843
12, .	40.0	855	85.5	29.80	1,044	1.0364	1,565
Averages, .	43.8	796	79.6	29.70	1,038	1.0359	1,459

Weight of animal at beginning of period, ... 99.25 lbs.
Weight of animal at end of period, ... 100.25 "

* See foot-note on page 157.

PERIOD IV. SHEEP III.

[Fodder consumed daily: 600 grams hay, 250 grams new-process linseed meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine * excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 6, .	47.0	655	65.5	29.68	1,108	1.0358	1,125
7, .	46.0	739	73.9	31.35	1,079	1.0346	1,120
8, .	38.0	640	64.0	28.17	982	1.0377	1,381
9, .	47.5	644	64.4	27.93	1,069	1.0349	1,205
10, .	43.5	676	67.6	27.88	1,140	1.0338	1,336
11, .	44.5	653	65.3	28.12	1,054	1.0379	720
12, .	40.0	698	69.8	29.04	1,001	1.0366	1,760
Averages, .	43.8	672	67.2	28.88	1,062	1.0359	1,235

Weight of animal at beginning of period, ... 95.75 lbs.
Weight of animal at end of period, ... 96.25 "

PERIOD V. SHEEP II.

[Fodder consumed daily: 600 grams hay, 250 grams old-process linseed meal and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine * excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 20, .	41.5	811	81.1	30.45	1,072	1.0350	393
21, .	35.0	716	71.6	28.00	839	1.0420	1,795
22, .	45.0	751	75.1	30.98	866	1.0400	1,368
23, .	46.0	746	74.6	30.60	955	1.0415	1,081
24, .	38.0	668	66.8	28.76	880	1.0405	1,293
25, .	37.0	656	65.6	27.97	956	1.0420	1,204
26, .	37.0	837	83.7	34.24	944	1.0400	1,148
Averages, .	40.1	741	74.1	30.14	930	1.0401	1,183

Weight of animal at beginning of period, ... 100.25 lbs.
Weight of animal at end of period, ... 99.50 "

* See foot-note on page 157.

Period V. Sheep III.

[Fodder consumed daily: 600 grams hay, 250 grams old-process linseed meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 20, .	41.5	660	66.0	29.15	974	1.0410	728
21, .	35.0	617	61.7	27.54	867	1.0405	1,715
22, .	45.0	637	63.7	27.57	951	1.0410	1,110
23, .	46.0	694	69.4	30.23	990	1.0400	1,499
24, .	38.0	543	54.3	25.88	1,191	1.0310	1,222
25, .	37.0	647	64.7	28.68	987	1.0390	697
26, .	37.0	682	68.2	29.18	1,133	1.0340	1,017
Averages, .	40.1	640	64.0	28.32	1,013	1.0381	1,141

Weight of animal at beginning of period, ... 95.50 lbs.
Weight of animal at end of period, ... 96.50 "

Period V. Sheep IV.

[Fodder consumed daily: 600 grams hay, 250 grams old-process linseed meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 6, .	47.0	752	75.2	29.29	1,376	1.0254	1,954
7, .	46.0	762	76.2	29.31	1,610	1.0216	1,731
8, .	38.0	846	84.6	33.02	1,163	1.0295	1,113
9, .	47.5	737	73.7	28.05	1,150	1.0292	1,427
10, .	43.5	809	80.9	30.95	1,174	1.0301	1,390
11, .	44.5	739	73.9	30.73	1,235	1.0296	1,450
12, .	40.0	645	64.5	25.99	1,271	1.0289	1,825
Averages, .	43.8	756	75.6	29.62	1,283	1.0278	1,556

Weight of animal at beginning of period, ... 102.75 lbs.
Weight of animal at end of period, ... 104.00 "

* See foot-note on page 157.

Period VI. Sheep I.

[Fodder consumed daily: 450 grams hay, 400 grams corn cobs, 250 grams new-process linseed meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
October 13, .	61	942.0	94.2	36.65	1,332	1.0227	2,428
14, .	68	956.0	95.6	38.71	1,074	1.0274	2,320
15, .	58	1,032.0	103.2	39.12	1,132	1.0276	1,875
16, .	50	918.0	91.8	35.57	971	1.0315	2,330
17, .	54	1,127.0	112.7	41.68	967	1.0313	1,362
18, .	56	1,019.0	101.9	35.87	1,024	1.0286	1,605
19, .	51	1,142.0	114.2	39.66	1,045	1.0280	1,953
Averages, .	57	1,019.4	101.9	38.18	1,078	1.0282	1,982

Weight of animal at beginning of period, ... 92.75 lbs.
Weight of animal at end of period, ... 94.75 "

Period VI. Sheep II.

[Fodder consumed daily: 400 grams hay, 400 grams corn cobs, 200 grams new-process linseed meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
October 6, .	59	829.0	82.9	35.33	726.0	1.0337	2,018
7, .	67	1,004.0	100.4	39.92	857.0	1.0319	1,852
8, .	61	946.0	94.6	33.39	810.0	1.0320	1,510
9, .	65	999.0	99.9	35.86	–	–	1,765
10, .	61	1,076.0	107.6	36.07	739.0	1.0357	1,696
11, .	61	1,040.0	104.5	34.80	751.0	1.0345	2,080
12, .	70	1,229.0	122.9	38.69	780.0	1.0374	1,070
Averages, .	63	1,018.3	101.8	36.29	777.1	1.0342	1,713

Weight of animal at beginning of period, ... 95.75 lbs.
Weight of animal at end of period, ... 97.00 "

* See foot-note on page 157.

Period VII. Sheep I.

[Fodder consumed daily: 500 grams hay, 400 grams dried brewers' grains and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 24, .	38.0	892	89.2	34.92	1,384	1.0180	2,392
25, .	37.0	875	87.5	33.61	1,437	1.0190	1,887
26, .	37.0	995	99.5	36.02	1,693	1.0170	1,515
27, .	30.0	787	78.7	30.67	1,370	1.0210	2,363
28, .	51.0	883	88.3	32.62	1,179	1.0205	963
29, .	43.5	955	95.5	36.93	1,157	1.0210	1,846
30, .	47.0	1,014	101.4	36.66	1,659	1.0160	2,065
Averages, .	40.5	914	91.4	34.49	1,411	1.0189	1,862

Weight of animal at beginning of period, ... 96.00 lbs.
Weight of animal at end of period, ... 95.75 "

Period VII. Sheep II.

[Fodder consumed daily: 500 grams hay, 400 grams dried brewers' grains and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
October 21, .	60.0	908.0	90.8	35.91	791	1.0307	1,560
22, .	52.0	939.0	93.9	38.44	780	1.0311	1,882
23, .	62.0	856.0	85.6	35.09	801	1.0288	1,328
24, .	64.0	825.0	82.5	35.95	786	1.0298	1,390
25, .	62.0	911.0	91.1	38.74	787	1.0301	1,910
26, .	47.0	897.0	89.7	35.41	911	1.0286	1,485
27, .	–	1,028.0	102.8	39.29	835	1.0292	1,133
Averages, .	57.8	909.1	90.91	36.98	813	1.0298	1,527

Weight of animal at beginning of period, ... 99.00 lbs.
Weight of animal at end of period, ... 100.25 "

* See foot-note on page 157.

Period VIII. Sheep II.

[Fodder consumed daily: 600 grams hay, 300 grams spring-wheat bran and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
December 5, .	26	842.0	84.2	30.21	1,157	1.0280	1,703
6, .	32	983.0	98.3	35.64	1,020	1.0310	897
7, .	33	854.0	85.4	31.48	894	1.0360	1,897
8, .	30	1,065.0	106.5	36.81	936	1.0295	1,181
9, .	29	1,107.0	110.7	37.40	840	1.0360	1,407
10, .	37	1,106.0	110.6	36.01	908	1.0340	1,484
11, .	32	1,160.0	116.0	38.13	915	–	1,425
Averages, .	31	1,016.7	101.7	35.10	953	1.0324	1,428

Weight of animal at beginning of period, ... 99.75 lbs.
Weight of animal at end of period, ... 100.25 "

Period VIII. Sheep III.

[Fodder consumed daily: 600 grams hay, 300 grams spring-wheat bran and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
December 5, .	26.0	750	75.0	29.04	911	1.0345	1,105
6, .	32.0	988	98.8	38.69	973	1.0345	40
7, .	33.5	918	91.8	34.30	754	1.0400	1,597
8, .	30.5	965	96.5	35.09	744	1.0345	1,709
9, .	29.0	965	96.5	35.07	796	1.0370	880
10, .	37.5	881	88.1	33.13	880	1.0380	1,318
11, .	32.5	1,000	100.0	37.36	897	–	1,020
Averages, .	31.6	924	92.4	34.67	851	1.0364	1,096

Weight of animal at beginning of period, ... 98.25 lbs.
Weight of animal at end of period, ... 97.75 "

* See foot-note on page 157.

Period IX. Sheep IV.

[Fodder consumed daily: 600 grams hay, 300 grams winter-wheat bran and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
November 21, .	35.0	982	98.2	32.87	1,114	1.0239	1,928
22, .	45.0	924	92.4	30.76	1,235	1.0220	1,790
23, .	46.0	1,246	124.6	41.04	1,194	1.0260	1,738
24, .	38.0	706	70.6	25.10	1,081	1.0270	2,178
25, .	37.0	973	97.3	33.57	1,182	1.0260	1,151
26, .	37.0	1,258	125.8	32.91	1,156	1.0260	1,443
27, .	30.0	1,083	108.3	34.71	1,309	1.0250	1,530
Averages, .	38.3	1,025	102.5	32.99	1,182	1.0251	1,680

Weight of animal at beginning of period, ... 105.25 lbs.
Weight of animal at end of period, ... 104.50 "

Period X. Sheep I.

[Fodder consumed daily: 600 grams hay, 300 grams wheat middlings and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
December 8, .	30.5	825	82.5	29.24	1,606	1.0165	2,271
9, .	29.0	934	93.4	32.60	1,929	1.0145	2,237
10, .	37.5	912	91.2	29.48	1,416	1.0140	2,411
11, .	32.5	877	87.7	30.16	1,799	–	2,325
12, .	29.0	880	88.0	29.73	1,809	1.0160	2,317
13, .	23.5	970	97.0	33.37	–	–	2,345
14, .	15.0	797	79.7	26.51	1,124	1.0230	–
Averages, .	28.1	885	88.5	30.16	1,614	1.0168	2,318

Weight of animal at beginning of period, ... 95.00 lbs.
Weight of animal at end of period, ... 93.75 "

* See foot-note on page 157.

PERIOD X. SHEEP IV.

[Fodder consumed daily: 600 grams hay, 300 grams wheat middlings and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample preserved.	Sample Air Dry.	Urine* excreted Daily, plus Wash Water.	Specific Gravity of Urine.	Water consumed Daily.
1893.	Degrees.	Grams.	Grams.	Grams.	Grams.		Grams.
December 6, .	32.0	774	77.4	26.20	964	1.0260	1,479
7, .	33.5	723	72.3	25.88	1,354	1.0240	1,285
8, .	30.5	860	86.0	31.53	932	1.0260	1,054
9, .	29.0	784	78.4	30.30	962	1.0295	1,326
10, .	37.5	741	74.1	27.70	791	1.0400	1,077
11, .	32.5	786	78.6	28.92	975	–	1,581
12, .	29.0	712	71.2	27.05	983	1.0300	964
Averages, .	30.6	769	76.9	28.23	994	1.0293	1,267

Weight of animal at beginning of period, ... 103.50 lbs.
Weight of animal at end of period, ... 103.25 "

* See foot-note on page 157.

The data furnished in the preceding tables enable us to calculate the *coefficients of digestibility* for the various foods, which will be found in the following pages.

English Hay (a). Period I.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
900 grams hay fed, . . .	758.16	229.98	26.38	84.16	367.79
11.43 grams waste,* . .	8.88	2.47	0.26	1.05	3.76
Total consumed, . . .	749.28	227.51	26.12	83.11	364.03
320.06 grams manure air dry,	294.67	84.62	11.22	30.49	132.99
Grams digested, . . .	454.61	142.89	14.90	52.62	231.04
Per cent. digested, . . .	60.67	62.80	57.04	63.31	63.46

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, . . .	769.50	233.39	26.77	85.42	373.30
20.71 grams waste,* . .	15.38	2.77	0.58	2.30	7.48
Total consumed, . . .	754.12	230.62	26.19	83.12	365.82
308.9 grams manure air dry, .	286.50	78.73	13.84	30.43	134.00
Grams digested, . . .	467.62	151.89	12.35	52.69	231.82
Per cent. digested, . . .	62.00	65.86	47.15	63.39	63.37

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, . . .	769.50	233.39	26.77	85.42	373.30
320.5 grams manure air dry, .	296.78	82.27	13.36	30.95	137.58
Grams digested, . . .	472.72	151.12	13.41	54.47	235.72
Per cent. digested, . . .	61.43	64.73	50.09	63.76	63.14
Average per cent. digested, .	**61.37**	**64.46**	**51.43**	**63.49**	**63.32**

Average nutritive ratio of ration for three sheep, 1 : 7.79.

* It will be noticed that in Period I., Sheep II. and III., and in Period II., Sheep II., small amounts of hay (the coarser portions) were not consumed ; these amounts were carefully collected, weighed, dry matter tests and complete analyses made.

Buffalo Gluten Feed. Period II.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
600 grams hay (*a*) fed, . .	501.06	151.97	17.44	55.62	243.06
12.5 grams waste,* . . .	9.71	2.76	0.28	1.10	4.32
Hay consumed, . . .	491.35	149.21	17.16	54.52	238.74
300 grams Buffalo gluten feed,	271.77	22.77	38.83	71.61	136.43
Total consumed, . . .	763.12	171.98	55.99	126.13	375.17
292.55 grams manure air dry,	259.73	69.19	14.26	30.06	116.65
Grams digested, . . .	503.39	102.79	41.73	96.07	258.52
Minus 600 grams hay digested,	298.10	93.70	9.79	34.52	151.50
Buffalo gluten feed digested, .	205.29	9.09	31.94	61.55	107.02
Per cent. digested, . . .	75.53	39.92	82.25	85.97	78.44

* See note on preceding page.

SHEEP IV.

600 grams hay fed, . . .	528.30	160.23	18.38	58.65	256.28
250 grams Buffalo gluten feed,	225.00	18.86	32.15	59.28	112.95
Total consumed, . . .	753.30	179.09	50.53	117.93	369.23
272.28 grams manure air dry,	247.77	66.65	15.41	30.77	112.12
Total digested, . . .	505.53	112.44	35.12	87.16	257.11
Minus 600 grams hay digested,	324.54	103.71	9.21	37.39	161.82
Buffalo gluten feed digested, .	180.99	8.73	25.91	49.77	95.29
Per cent. digested, . . .	80.44	46.28	80.58	83.94	84.37
Average per cent. two sheep digested, ...	**77.98**	**43.10**	**81.41**	**84.95**	**81.40**

Average nutritive ratio of ration for two sheep, 1 : 5.03.

English Hay (b). Period III.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
900 grams hay fed, . . .	765.36	250.58	23.57	82.58	348.69
369.3 grams manure air dry, .	337.95	107.00	12.81	34.64	145.89
Amount digested, . . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, . . .	55.84	57.30	45.65	58.05	58.16

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, . . .	765.36	250.58	23.57	82.58	348.69
375.3 grams manure air dry, .	343.62	110.51	12.44	34.57	150.61
Amount digested, . . .	421.74	140.07	11.13	48.01	198.08
Per cent. digested, . . .	55.10	55.90	47.22	58.13	56.80

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, . . .	765.36	250.58	23.57	82.58	348.69
371.54 grams manure air dry,	339.33	106.78	12.38	36.27	145.60
Amount digested, . . .	426.03	143.80	11.19	46.31	203.09
Per cent digested, . . .	55.56	57.38	47.47	56.08	58.24

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed, . . .	765.36	250.58	23.57	82.58	348.69
371.77 grams manure air dry,	337.83	105.30	12.43	35.47	145.77
Amount digested, . . .	427.53	145.28	11.14	47.11	202.92
Per cent. digested, . . .	55.86	57.98	47.26	57.04	58.19
Average per cent. four sheep digested, ...	**55.57**	**57.14**	**46.90**	**57.32**	**57.85**

Average nutritive ratio of ration for three sheep, 1 : 7.89.

By feeding the following grains in connection with English hay (*b*) we are enabled to find their coefficients of digestibility.

New-process Linseed Meal. Period IV.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
600 grams hay fed, . . .	526.38	172.34	16.21	56.79	239.82
250 grams new-process linseed meal, ...	220.70	18.96	8.85	89.16	90.84
Total consumed, . . .	747.08	191.30	25.06	145.95	330.66
297.01 grams manure air dry,	280.76	85.63	9.40	35.96	116.01
Amount digested, . . .	466.32	105.67	15.66	109.99	214.65
Minus 600 grams hay digested,	290.06	96.33	7.65	33.02	136.24
Remains linseed meal digested,	176.26	9.34	8.01	76.97	78.41
Per cent. digested, . . .	79.86	49.24	90.50	86.32	86.31

SHEEP III.

Total consumed, as above, .	747.08	191.30	25.06	145.95	330.66
288.81 grams manure air dry,	271.77	78.52	9.27	35.49	114.04
Total digested, . . .	475.31	112.78	15.79	110.46	216.62
Minus 600 grams hay digested,	293.01	98.90	7.69	31.85	139.67
Remains linseed meal digested,	182.30	13.88	8.10	78.61	76.95
Per cent. digested, . . .	82.60	73.21	91.52	88.16	84.71
Average per cent. two sheep digested, ...	**81.23**	**61.23**	**91.01**	**87.24**	**85.51**

Average nutritive ratio of ration for two sheep, 1 : 3.30.

Old-process Linseed Meal. Period V.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
600 grams hay fed, . . .	517.38	169.42	15.94	55.83	235.72
250 grams old-process linseed meal, ...	218.18	17.91	18.04	80.18	86.83
Total consumed, . . .	735.56	187.33	33.98	136.01	322.55
301.43 grams manure air dry, .	285.76	85.87	9.86	34.29	120.62
Total digested, . . .	449.80	101.46	24.12	101.72	201.93
Minus 600 grams hay digested,	285.10	94.69	7.52	32.46	133.91
Remains old-process linseed meal digested, . . .	164.70	6.77	16.60	69.26	68.02
Per cent. digested, . . .	75.48	37.80	92.01	86.38	78.33

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, .	735.56	187.33	33.98	136.01	322.55
283.20 grams manure air dry,	268.10	77.32	11.02	29.84	116.89
Total digested, . . .	467.46	110.01	22.96	106.17	205.66
Minus 600 grams hay digested,	288.00	97.21	7.57	31.31	137.29
Remains old-process linseed meal digested, . . .	179.46	12.80	15.39	74.86	68.37
Per cent. digested, . . .	82.25	71.47	85.30	93.36	78.73

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay consumed, .	526.38	172.34	16.21	56.79	239.82
250 grams old-process linseed meal, ...	220.00	18.06	18.19	80.85	87.56
Total consumed, . . .	746.38	190.40	34.40	137.64	327.38
296.2 grams manure air dry, .	280.20	79.32	10.65	35.19	121.64
Total digested, . . .	466.18	111.08	23.75	102.45	205.74
Minus 600 grams hay digested,	294.04	99.92	7.66	32.40	139.56
Remains old-process linseed meal digested, . . .	172.14	11.16	16.09	70.05	66.18
Per cent. digested, . . .	78.24	61.79	88.45	86.64	75.58
Average per cent. three sheep digested, ...	**78.66**	**57.02**	**88.59**	**88.79**	**77.55**

Average nutritive ratio of ration for three sheep, 1 : 3.59.

Corn (Maize) Cobs. Period VI.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
450 grams hay fed, . . .	384.03	125.72	11.83	41.44	174.96
400 grams corn cobs, . .	351.56	95.51	4.50	13.57	231.21
250 grams new-process linseed meal, ...	220.25	18.92	8.83	88.98	90.65
Total consumed, . . .	955.84	240.15	25.16	143.99	496.82
381.8 grams manure air dry, .	353.05	97.19	9.25	40.14	177.23
Total digested, . . .	602.79	142.96	15.91	103.85	319.59
Minus 450 grams hay digested, ... Minus 250 grams new-process linseed meal digested, .	390.34	81.36	13.39	100.88	180.00
Remains corn cobs digested, .	212.45	61.60	2.52	2.97	139.59
Per cent. digested, . . .	60.43	64.50	56.00	21.88	60.37

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
400 grams hay fed, . . .	334.48	109.50	10.30	36.09	152.39
400 grams corn cobs, . .	351.56	95.51	4.50	13.57	231.21
200 grams new-process linseed meal, ...	177.14	15.22	7.10	71.56	72.91
Total consumed, . . .	863.18	220.23	21.90	121.22	456.51
362.94 grams manure air dry,	331.73	88.34	8.62	36.72	168.95
Total digested, . . .	531.45	131.89	13.28	84.50	287.56
Minus 400 grams hay digested, Minus 200 grams new-process linseed meal digested, .	325.76	68.70	11.29	82.75	149.49
Remains corn cobs digested, .	205.69	63.19	1.99	1.75	138.07
Per cent. digested, . . .	58.51	66.16	44.22	12.89	59.71
Average per cent. two sheep digested, ...	**59.47**	**65.33**	**50.11**	**17.38**	**60.04**

Nutritive ratio of ration, Sheep I., 1 : 4.84; nutritive ratio of ration, Sheep II., 1 : 5.36.

Dried Brewers' Grains. Period VII.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
500 grams hay fed, . . .	433.00	141.76	13.34	46.72	197.27
400 grams brewers' grains, .	358.72	52.09	28.02	82.47	183.27
Total consumed, . . .	791.72	193.85	41.36	129.19	380.54
344.9 grams manure air dry, .	328.83	83.91	9.27	37.98	158.23
Total digested, . . .	462.89	109.94	32.09	91.21	222.31
Minus 500 grams hay digested,	241.79	81.23	6.09	27.12	114.73
Remains brewers' grains digested, ...	221.10	28.71	26.00	64.09	107.58
Per cent. digested, . . .	61.63	55.11	92.79	77.71	58.70

SHEEP II.

Total consumed, as above, .	791.72	193.85	41.36	129.19	380.54
355.47 grams manure air dry,	331.87	88.54	10.00	35.38	160.42
Total digested, . . .	459.85	105.31	31.36	93.81	220.12
Minus 500 grams hay digested,	238.59	79.24	6.30	27.16	112.05
Remains brewers' grains digested, ...	221.26	26.07	25.06	66.65	108.07
Per cent. digested, . . .	61.68	50.04	89.43	80.82	58.96
Average per cent. two sheep digested, ...	**61.65**	**52.57**	**91.11**	**79.26**	**57.83**

Average nutritive ratio of ration for two sheep, 1 : 4.40.

Spring Wheat Bran. Period VIII.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
600 grams hay fed, . . .	523.44	171.37	16.12	56.48	238.48
300 grams spring-wheat bran,	261.93	30.07	14.14	46.07	155.56
Total consumed, . . .	785.37	201.44	30.26	102.55	394.04
350.97 grams manure air dry,	333.84	98.98	11.95	33.92	150.36
Total digested, . . .	451.53	102.46	18.31	68.63	243.68
Minus 600 grams hay digested,	288.44	95.79	7.61	32.84	135.48
Remains spring-wheat bran digested, ...	163.09	6.67	10.70	35.79	108.20
Per cent. digested, . . .	62.26	22.18	75.67	77.68	69.55

SHEEP III.

Total consumed, as above, .	785.37	201.44	30.26	102.55	394.04
346.69 grams manure air dry,	329.49	95.58	11.93	33.28	144.35
Total digested, . . .	455.88	105.86	18.33	69.27	249.69
Minus 600 grams hay digested,	291.38	98.34	7.65	31.68	138.90
Remains spring-wheat bran digested, ...	164.50	7.52	10.68	37.59	110.79
Per cent. digested, . . .	62.80	0.25	75.53	81.59	71.22
Average per cent. two sheep digested, ...	**62.53**	**23.59**	**75.60**	**79.63**	**70.38**

Nutritive ratio of ration for two sheep, 1 : 5.75.

Winter-Wheat Bran. Period IX.

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
600 grams hay fed, . . .	517.38	169.39	15.94	55.82	235.72
300 grams winter-wheat bran,	259.47	24.18	11.86	44.22	163.03
Total consumed, . . .	776.86	193.57	27.80	100.04	398.75
329.94 grams manure air dry,	315.42	81.75	13.09	33.47	146.74
Total digested, . . .	461.43	111.82	14.71	66.57	252.01
Minus 600 grams hay digested,	289.01	98.21	7.53	31.84	137.18
Remains winter-wheat bran digested, ...	172.42	13.61	7.18	34.73	114.83
Per cent. digested, . . .	**66.45**	**56.28**	**60.54**	**78.54**	**70.43**

Nutritive ratio of ration, 1 : 6.02.

Wheat Middlings.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
	Grams.	Grams.	Grams.	Grams.	Grams.
600 grams hay fed, . . .	523.44	171.37	16.12	56.48	238.48
300 grams wheat middlings, .	260.82	9.21	15.91	54.93	176.86
Total consumed, . . .	784.26	180.58	32.03	111.41	415.34
301.56 grams manure air dry,	284.64	79.39	10.67	33.67	127.32
Total digested, . . .	499.62	101.19	21.36	77.74	288.02
Minus 600 grams hay digested,	292.30	98.19	7.36	32.79	138.70
Remains wheat middlings digested, ...	207.32	3.00	14.00	44.95	149.32
Per cent. digested, . . .	79.48	32.57	87.99	81.83	84.43

SHEEP IV.

Total consumed, as above, .	784.26	180.58	32.03	111.41	415.34
282.26 grams manure air dry,	268.51	77.54	11.41	30.99	115.46
Total digested, . . .	515.75	103.04	20.62	80.42	299.88
Minus 600 grams hay digested,	292.40	99.35	7.62	32.22	138.78
Remains wheat middlings digested, ...	223.35	3.69	13.00	48.20	161.10
Per cent. digested, . . .	85.63	40.06	81.71	87.75	91.08
Average per cent. two sheep digested, ...	**82.55**	**36.31**	**84.85**	**84.79**	**87.75**

Average nutritive ratio of ration for both sheep, 1 : 5.61.

A *résumé* of the coefficients will be found on page 152.

A compilation of the results of all digestion experiments made in the United States will be found in the rear portion of this report.

VII.

NOTES ON FEEDING FARM HORSES.
1888–93.

Rations for Farm Horses.

The following data are presented in order to show how the horses kept at the station have been fed during the past few years. The two farm horses, Fan and Bess, do an average amount of work during the spring, summer and autumn. In the winter season the work is light. Molly, whose record first appears in January, 1892, has been used for driving and express work.

During the winter of 1892, when the horses had comparatively little to do, the grain rations were reduced one-third. The so-called provender consists of cracked corn and oats mixed in the proportion of four hundred pounds of corn to fifteen bushels of oats. The horses were weighed weekly, and the average monthly weights will be found in Table III. The horses have been in uniform good condition during the several years.

Table I. (Horses Fan, Bess and Molly.)

Ration.		Food consumed Daily (Pounds). Hay.	Wheat Bran.	Provender.	Nutritive Ratio.	Total Dry Matter (Pounds).	Total Digestible Matter (Pounds).	Cost per Day (Cents).
I.,	Aug., 1888, to June, 1889,	18.00	2.00	6.00	1:7.92	23.23	14.39	23.34
II.,	June, 1889, to Jan., 1892,	20.00	2.00	6.00	1:7.99	25.03	15.41	24.84
III.,	Jan., 1892, to May, 1892,	15.00	2.00	4.00	1:7.22	18.78	11.42	18.49
IV.,	May, 1892, to Jan., 1894,	15.00	3.00	6.00	1:7.81	21.43	13.26	22.09

The above table shows the daily rations fed during the several years, the nutritive ratios of the feed, the average

amount of dry matter and digestible matter consumed daily and the average daily cost of the rations.

The following table shows the pounds of digestible nutrients in Ration IV., as compared with Wolff's standard for horses of one thousand pounds live weight, doing average work and hard work : —

Table II.

	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Matter (Pounds).	Nutritive Ratio.
Ration IV., ...	1.58	0.43	11.25	13.26	1 : 7.81
Wolff's standard, average work, ...	1.55	0.55	10.85	12.95	1 : 7.80
Wolff's standard, very hard work, ...	2.12	0.83	12.63	15.58	1 : 7.00

Table III., showing Average Monthly Weight of the Horses (Pounds).

Ration.	Year.	Name of Horse.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
I.,	1888,	Fan,	–	–	–	–	–	–	–	1,089	1,090	1,103	1,101	1,115
I.,	1888,	Bess,	–	–	–	–	–	–	–	1,107	1,115	1,115	1,116	1,126
I.,	1889,	Fan,	1,108	1,104	1,104	1,114	1,095	–	–	–	–	–	–	–
I.,	1889,	Bess,	1,109	1,092	1,101	1,123	1,116	–	–	–	–	–	–	–
II.,	1889,	Fan,	–	–	–	–	–	1,110	1,083	1,082	1,079	1,086	1,101	1,106
II.,	1889,	Bess,	–	–	–	–	–	1,129	1,108	1,095	1,108	1,103	1,118	1,109
II.,	1890,	Fan,	1,131	1,119	1,112	1,098	1,120	1,123	1,127	1,124	1,102	1,108	1,108	1,119
II.,	1890,	Bess,	1,120	1,126	1,119	1,110	1,119	1,118	1,129	1,134	1,125	1,121	1,126	1,107
II.,	1891,	Fan,	1,111	1,106	1,107	1,105	1,103	1,100	1,114	1,100	1,101	1,121	1,125	1,138
II.,	1891,	Bess,	1,110	1,077	1,099	1,097	1,109	1,115	1,126	1,120	1,117	1,126	1,137	1,144
III.,	1892,	Fan,	1,108	1,122	1,117	1,113	–	–	–	–	–	–	–	–
III.,	1892,	Molly,	1,062	1,063	1,063	1,038	–	–	–	–	–	–	–	–
III.,	1892,	Bess,	1,143	1,145	1,129	1,126	–	–	–	–	–	–	–	–
IV.,	1892,	Fan,	–	–	–	–	1,119	1,098	1,078	1,094	1,075	1,103	1,102	1,099
IV.,	1892,	Molly,	–	–	–	–	1,037	1,019	1,085	1,036	1,057	1,056	1,066	1,085
IV.,	1892,	Bess,	–	–	–	–	1,127	1,112	1,101	1,108	1,081	1,086	1,084	1,107
IV.,	1893,	Fan,	1,103	1,135	1,124	1,133	1,126	1,114	1,104	1,100	1,076	1,087	1,111	1,111
IV.,	1893,	Molly,	1,090	1,095	1,085	1,076	1,074	1,070	1,068	1,082	1,053	1,083	1,080	1,113
IV.,	1893,	Bess,	1,111	1,092	1,062	1,071	1,078	1,040	1,070	1,065	1,065	1,033	1,080	1,101

Remarks.

It will be noticed that the average weight of the horses has been well sustained by the various rations fed. Table III. makes this very clear. Slight variations are noted at times, due probably to the fact that the horses were obliged to do rather more than the average work for a short time.

Ration III., fed when the horses were doing very light work, proved sufficient to keep them in good condition, and costs several cents less per day than the others. Ration IV. gives very good results, and costs somewhat less than Rations I. and II. The cost of the several rations is based on an approximate average market cost of the several foods. This average will be found below. Ration IV. contains about the same amount of digestible nutrients as given by Wolff for horses doing average work.

Average Market Cost of the Various Foods fed.

Hay,	$15 00 per ton.
Wheat bran,	20 00 "
Cracked corn,	24 00 "
Oats (thirty-two pounds per bushel),	0 45 per bushel.

Average Composition of Fodder Stuffs.

	Hay.	Wheat Bran.	Provender.
Moisture at 100° C.,	10.15	10.49	12.16
Dry matter,	89.85	89.51	87.84
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	6.21	7.01	2.58
" cellulose,	32.15	10.89	6.96
" fat,	2.38	5.00	5.11
" protein,	9.67	17.78	12.25
Non-nitrogenous extract matter,	49.59	59.32	73.04
	100.00	100.00	100.00

PART II.

FIELD EXPERIMENTS.

C. A. GOESSMANN.

1. FIELD EXPERIMENTS TO ASCERTAIN THE EFFECT OF THE EXCLUSION OF EVERY FORM OF NITROGEN-CONTAINING MANURIAL MATTER FROM THE FERTILIZER APPLIED FOR THE PRODUCTION OF A GRAIN CROP — OATS — ON ITS YIELD PER ACRE (FIELD A).
2. FIELD EXPERIMENTS WITH PROMINENT VARIETIES OF GRASSES AND GRASS MIXTURES UNDER FAIRLY CORRESPONDING CIRCUMSTANCES AND WITH DIFFERENT VARIETIES OF POTATOES (FIELD B).
3. FIELD EXPERIMENTS REGARDING THE EFFECT OF DIFFERENT COMBINATIONS OF COMMERCIAL FERTILIZERS ON THE YIELD OF SOME PROMINENT GARDEN CROPS (FIELD C).
4. OBSERVATIONS REGARDING THE ADAPTATION OF A VARIETY OF MORE OR LESS REPUTED FODDER PLANTS NEW TO OUR SECTION OF THE COUNTRY (FIELD D).
5. FIELD EXPERIMENTS WITH DIFFERENT COMMERCIAL PHOSPHATES, TO STUDY THE ECONOMY OF USING THE CHEAPER NATURAL PHOSPHATES OR THE MORE COSTLY ACIDULATED PHOSPHATES (FIELD F).
6. FIELD EXPERIMENTS TO SHOW THE EFFECT OF BARN-YARD MANURE ON THE YIELD OF CORN (FIELD G).
7. FIELD EXPERIMENTS TO DETERMINE THE EFFECT OF VARIOUS FERTILIZER MIXTURES ON LEGUMINOUS AND GRAIN CROPS (EAST FIELD).
8. OBSERVATIONS ON PERMANENT GRASS LANDS — MEADOWS.
9. REPORT ON GENERAL FARM WORK.
10. OBSERVATIONS ON SPECIAL FERTILIZATION WITH REFERENCE TO SOME PROMINENT INDUSTRIAL CROPS, FRUITS AND GARDEN VEGETABLES.

1. Field Experiments carried on for the Purpose of ascertaining the Effect of the Exclusion of Every Form of Nitrogen-containing Manurial Matter from the Fertilizer applied for the Production of Oats on the Yield, as compared with the Results obtained when a Liberal Amount of Various Nitrogen-containing Manurial Substances is applied under Otherwise Corresponding Circumstances for the Same Purpose.

Field A.

The unbroken record of this field extends over more than twenty years. The systematic treatment of the soil, as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-eighth of an acre each), of a uniform size and shape, one hundred and thirty feet long and thirty feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

Since 1889 the main object of observations upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial. The treatment of the soil adopted in preceding years favored this new project for field observations, as may be noticed from the following remarks.

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under

cultivation, while the remaining ones received as before a definite amount of nitrogen in the same form in which they had received it in preceding years; namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood or of barn-yard manure. A corresponding amount of available nitrogen was applied in all these cases.

Aside from the difference regarding the nitrogen supply, all plats were treated alike. They each received without an exception a corresponding amount of available phosphoric acid and of potassium oxide. The phosphoric acid was supplied in form of dissolved bone-black, and the potassium oxide either in form of muriate of potash or of potash-magnesia sulphate.

Amount of Fertilizing Ingredients used Annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	80 pounds.
	Potassium oxide,	125 pounds.

One plat marked 0 received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of the three essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

The subsequent tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early as circumstances permitted. They were well harrowed under before the seed was planted in rows by a seed drill.

PLATS.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Cost of Fertilizers applied to Field A.

	Cost per Plat.	Cost per Acre.
Plat 0, ...	$2 28	$22 75
Plat 1, ...	1 99	19 90
Plat 2, ...	2 43	24 30
Plat 3, ...	2 09	20 90
Plat 4, ...	1 23	12 30
Plat 5, ...	2 46	24 58
Plat 6, ...	2 02	20 18
Plat 7, ...	1 23	12 30
Plat 8, ...	2 02	20 18
Plat 9, ...	1 23	12 30
Plat 10, ...	2 53	25 30

The above-described course of the general management of the experiment has been followed thus far for five consecutive years (1889–93, inclusive).

Kind of Crops raised.

Corn (maize), ...	in 1889.
Oats, ...	in 1890.
Rye, ...	in 1891.
Soja bean, ...	in 1892.
Oats, ...	in 1893.

For details regarding earlier years (1889–92), see corresponding annual reports.

Summary of Four Years' Observations upon Field A (1889–92).

Number of Plat.	1889. Corn.	1890. Yield of Oats.					1891. Yield of Rye.					1892.
	Yield of Dry Fodder Corn (Pounds).	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Yield of Grain (Pounds).	Yield of Straw (Pounds).	Crop (Pounds).	Percentage of Grain.	Percentage of Straw and Chaff.	Yield of Grain (Pounds).	Yield of Straw (Pounds).	Yield of Green Soja Bean (Pounds).
Plat 0, . .	–	315	38.10	61.90	120	195	470	30.21	69.79	142	328	2,210
Plat 1, . .	648	362	35.36	64.64	128	234	570	27.02	72.98	154	416	2,290
Plat 2, . .	577	365	35.34	64.66	129	236	525	25.52	74.48	134	391	2,290
Plat 3, . .	618	345	33.62	66.38	116	229	475	27.37	72.63	130	345	2,090
Plat 4, . .	381	260	34.61	63.39	90	170	390	27.44	72.56	107	283	1,440
Plat 5, . .	488	360	39.20	60.80	141	219	530	27.36	72.64	145	385	1,935
Plat 6, . .	542	385	32.21	67.79	124	261	400	25.50	74.50	102	298	1,970
Plat 7, . .	526	320	34.40	65.60	110	210	450	24.22	75.78	109	341	1,430
Plat 8, . .	359	220	26.82	73.18	59	161	–	–	–	–	–	1,450
Plat 9, . .	476	290	34.83	65.17	101	189	425	25.65	74.35	109	316	1,460
Plat 10, . .	640	395	35.44	64.56	140	255	425	29.41	70.59	125	300	1,490

Plat 8 has shown, as has been repeatedly pointed out throughout the entire experiment, exceptional conditions, due apparently to injury by insects in the early stage of the growth.

The low yield of Plat 10 in 1892 is evidently due to the use of a lower rate of seed, being the first plat to adjust the seed drill for a definite amount of seed.

An examination of the above tabular statement of the annual yield of the various crops upon the different plate shows that as a rule those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that received annually in some form or other an addition of available nitrogen. It seemed but proper to sum up in our last annual report our results in the following statement: —

The experiments carried on upon Field A during the years 1889, '90, '91 and '92 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen, to serve a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soja bean, when for the first time raised upon Field A, did not furnish an exception to our observation.

The stated conclusion is in full accord with careful observations of others when raising upon a field for the first time clover or clover-like plants. A deficiency of the soil in regard to the peculiar lower organisms, which in case of clover-like plants are recognized as the medium to assist in the conversion of the atmospheric nitrogen into nitrogenous plant food, is usually considered the cause of the results. This class of crops frequently does better on a second trial upon the same lands.

A liberal introduction of annual leguminous crops into our system of raising field crops is known to improve the nitrogen resources of the farm lands in an economical way.

1893. — The main object of our experiment upon Field A during this season was to observe the after-effect of the cultivation of soja bean (a leguminous crop) on the nitrogen resources of the soil which served for its production. It seemed of interest in our case to ascertain whether the raising of the soja bean upon Field A had increased the amount of available nitrogen stored up in the soil to such an extent as to affect the yield of the succeeding crop upon those plats (4, 7, 9), which as a rule did not receive at any time an addition of available nitrogen from any other manurial source but the atmospheric air and the roots of the soja beans left in the soil after harvesting the crop.

Oats were selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in preceding years, as will be seen from the subsequent description of the operation.

The field was ploughed Sept. 22, 1892; during the succeeding March the barn-yard manure was applied broadcast to Plat 0, and April 29 the entire field was again ploughed. The remaining plats, 1–10, received their different fertilizer mixtures broadcast on May 4. The entire field was harrowed and pulverized a few days later. The oats were sown May 15, in drills two and a half feet apart, at the rate of three and two-thirds pounds per plat. The seed when tested by germination showed eighty-two per cent. of live seed. The young plants appeared above ground May 22. June 2 and again June 17 all plats were cultivated and hoed.

Height of the Oats upon the Different Plats of Field A during the Season (1893).

[Inches.]

	July 3.	July 10.	July 17.	July 24.	July 31.	August 7.
Plat 0, . . .	20	25	34	44	44	45
Plat 1, . . .	23	30	39	45	46	46
Plat 2, . . .	24	27	39	44	46	46
Plat 3, . . .	20	27	38	44	46	47
Plat 4, . . .	18	20	34	36	40	41
Plat 5, . . .	23	24	36	45	45	46
Plat 6, . . .	20	23	33	40	43	47
Plat 7, . . .	19	23	36	41	44	46
Plat 8, . . .	14	17	29	35	40	46
Plat 9, . . .	19	22	35	38	42	44
Plat 10, . . .	23	31	39	47	48	48

The color of the crop varied on different plats considerably throughout the season. Those receiving no nitrogen appeared

yellowish-green, while those which received nitrogen in the form of dried blood were especially dark-green colored. The crop raised on the plats which received nitrogen in the form of sulphate of ammonia retained the green color somewhat longer than that of the remaining plats.

The crop was cut August 14, 15.

Yield of Oat Crop on Different Plats (1893).

[Pounds.]

	Weight of Oats.	Weight of Oats per Acre.	Weight of Straw and Chaff.	Weight of Grain.	Weight of Straw and Chaff per Acre.	Weight of Grain per Acre.
Plat 0,	530	5,300	399	131	3,990	1,310
Plat 1,	690	6,900	555	135	5,550	1,350
Plat 2,	600	6,000	454	146	4,540	1,460
Plat 3,	700	7,000	534	166	5,340	1,660
Plat 4,	590	5,900	430	160	4,300	1,600
Plat 5,	630	6,300	551	79	5,510	790
Plat 6,	600	6,000	498	102	4,980	1,020
Plat 7,	550	5,500	431	119	4,310	1,190
Plat 8,	420	4,200	325	95	3,250	950
Plat 9,	480	4,800	370	110	3,700	1,100
Plat 10,	610	6,100	485	125	4,850	1,250

Ratio of Grain to Straw.

Plat 0,	1:3	Plat 6,	1:4.9
Plat 1,	1:4.1	Plat 7,	1:3.6
Plat 2,	1:3.1	Plat 8,	1:3.4
Plat 3,	1:3.2	Plat 9,	1:3.4
Plat 4,	1:2.7	Plat 10,	1:3.9
Plat 5,	1:7		

Conclusions. — An examination of the results given above shows that the total crop on those plats to which no nitrogen was applied (4, 7 and 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other.

Plat 8 shows again the exceptional conditions of previous years, for, although fertilized in a like manner as Plat 6, its total yield was 1,800 pounds less.

In yield of grain those plats which received their nitrogen in the form of sulphate of ammonia (5, 6 and 8) averaged 92 pounds; those in the form of organic nitrogen (0, 6 and 8), 140⅔ pounds; those in the form of nitrate of soda (1 and 2), 140½ pounds.

The best results in relation of total yield to yield of grain were obtained in the case of those plats receiving organic nitrogen (dried blood and barn-yard manure), or nitrogen in the form of nitrate of soda; while in the case of sulphate of ammonia the ratio of grain to straw was too wide to give the best satisfaction.

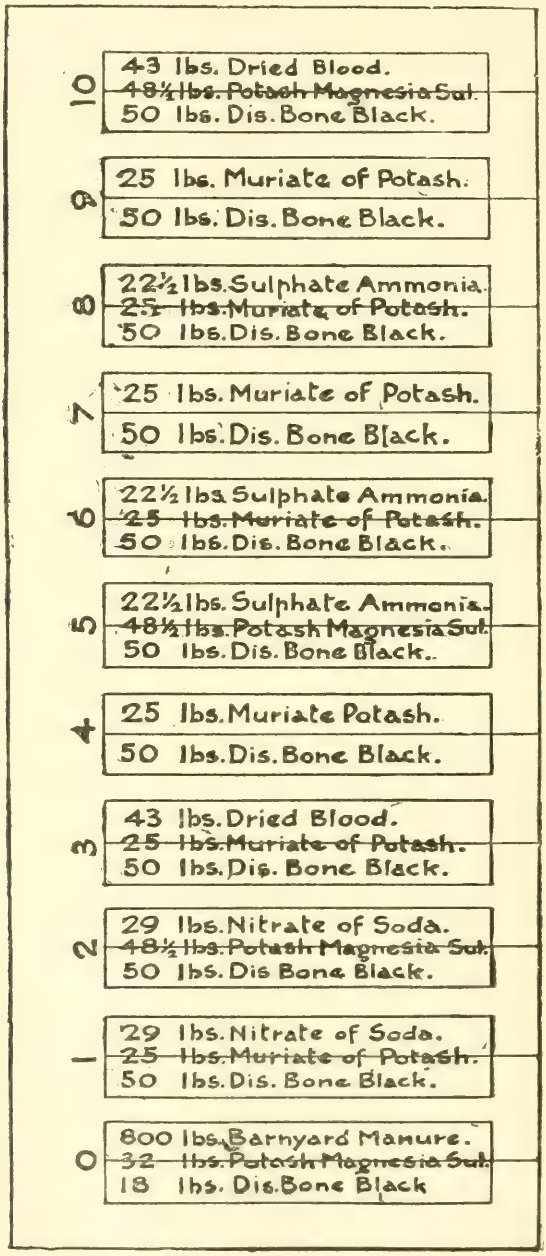
The total yield of crop on the plats receiving no nitrogen addition, as compared with those receiving a nitrogen supply, was: —

With oats in 1890, one-fifth to one-sixth less;
With rye in 1891, one-fifth to one-sixth less;
With soja bean in 1892, one-third to one-fourth less;
With oats in 1893, one-seventh to one-eighth less.

From this it will appear that the introduction of a leguminous crop into our rotation has somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet has not entirely obliterated it.

These experiments will be continued another year, with some modifications.

Field "A," 1893.



SCALE, 4 RODS TO 1 INCH.

2. Field Experiments with Several Prominent Varieties of Grasses and of Potatoes.

Field B.

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21. From 1884 to 1889 every alternate plat received annually the same kind and the same amount of fertilizer, — 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre.

From 1889 to the close of the season of 1892 all plats were treated alike, as far as the system of cultivation and of manuring is concerned. The previously stated unmanured plats (12, 14, 16, 18 and 20) received from 1890, like the remaining plats (11, 13, 15, 17, 19 and 21), as manure annually at the rate of 600 pounds of fine-ground bone and 200 pounds of muriate of potash, applied broadcast either as a top dressing or thoroughly ploughed under, as circumstances admitted.

For details regarding the work carried on upon Field B previous to 1892, see tenth annual report.

The character of the crops raised during 1892 may be noticed from the subsequent tabular statement: —

Crops raised in 1892.

Plats.	1892.
Plat 11, .	Kentucky blue-grass, sown Sept. 24, 1889.
Plat 12, .	Kentucky blue-grass and red top, sown Sept. 18, 1891.
Plat 13,	English rye-grass and Italian rye-grass, sown Sept. 29, 1890.
Plat 14, .	English rye-grass and red top, sown Sept. 29, 1890.
Plat 15, .	Herds grass and red top, sown April 23, 1891.
Plat 16, .	Italian rye-grass and red top, sown April 23, 1891
Plat 17, .	Meadow fescue, sown Sept. 25, 1887.
Plat 18, .	Meadow fescue, sown Sept. 29, 1890.
Plat 19, .	Herds grass, sown Sept. 25, 1889.
Plat 20, .	Herds grass and red top, sown Sept. 29, 1890.
Plat 21, .	Meadow fescue and herds grass, sown Sept. 18, 1891.

Area of Each Plat, Two-fifteenths Acre.	Yield of Hay, First and Second Cut (Pounds).	Rate per Acre (Pounds).
Plat 11, sown Sept. 24, 1889, ...	335	2,513
Plat 12, sown Sept. 18, 1891, ...	365	2,737
Plat 13, sown Sept. 29, 1890, ...	255	1,913
Plat 14, sown Sept. 29, 1890, ...	225	1,688
Plat 15, sown April 23, 1891, ...	565	4,238
Plat 16, sown April 23, 1891, ...	565	4,238
Plat 17, sown Sept. 25, 1887, ...	475	3,563
Plat 18, sown Sept. 29, 1890, ...	490	3,675
Plat 19, sown Sept. 25, 1889, ...	610	4,575
Plat 20, sown Sept. 29, 1890, ...	285	2,138
Plat 21, sown Sept. 18, 1891, ...	355	2,663
Total, ...	4,525	

At the close of the season (1892) it was decided to raise hereafter other crops than grasses upon plats 11, 13, 14, 15, 16 and 20. For this reason they were ploughed after the rowen had been secured, while plats 12, 17, 18, 19 and 21 remained in grass for another season.

1893. — Plats 11, 13, 14, 15, 16 and 20, which had been used for several preceding years for the production of grasses, were at an early date prepared to serve for experiments with several prominent varieties of potatoes. They were ploughed in August, 1892, and were again ploughed for the final preparation April 25, 1893.

It was proposed to compare the yield, as far as quantity and quality are concerned, under otherwise corresponding circumstances. Three varieties of potatoes, Beauty of Hebron, Clark's, New Queen, were chosen for the trial. The seed potatoes were obtained of J. J. H. Gregory & Son, Marblehead.

Two plats, 15 and 16, were assigned for the cultivation of Beauty of Hebron; two, 13 and 14, for that of New Queen; and two, 11 and 20, for that of Clark's variety.

One plat in each case received its potash supply in form of muriate of potash (plats 11, 13 and 15), and one in each case in that of high-grade sulphate of potash.

The actual amount of potassium oxide used in all cases remained the same.

Statement of Fertilizers used (Pounds).

		Per Plat.	Per Acre.
Plats 11, 13, 15,	Muriate of potash,	54	400
	Bone,	80	600
Plats 14, 16, 20,	Sulphate of potash (high grade),	54	400
	Bone,	80	600

Composition of Fertilizers used.

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone,	4.02	–	22.96
Sulphate of potash,	–	50.20	–
Muriate of potash,	–	46.00	–

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 11, 13, 15,	$2 39	$17 93
Plats 14, 16, 20,	2 66	19 95

The final mechanical preparation of the different plats was the same in all cases. The fertilizer was applied broadcast, and subsequently thoroughly harrowed in before planting. The potatoes were planted May 10 on all plats at the rate of nineteen bushels per acre, or two and one-half bushels potatoes per plat. Potatoes used were either whole ones of medium size, or when larger were cut in pieces of sizes corresponding to the former. Plats 11 and 20 were planted with Clark's variety; plats 13 and 14 were planted with New Queen variety; plats 15 and 16 were planted with Beauty of Hebron variety.

The crop began to break ground May 26, and was subsequently cultivated and hoed June 5 and June 20. The potatoes were in bloom June 24, and the tops began to die August 14. The crop was harvested August 23 and 24.

The potatoes were in all cases of a superior appearance; only one-eighth to one-ninth of the entire crop was not marketable as a first-class article, on account of small size.

Yield of Crop.

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

VARIETY.	Amount per Plat.			Rate per Acre.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 11, Clark's, . .	1,450	225	1,675	10,875	1,688	12,563
Plat 13, New Queen, . .	1,620	240	1,860	12,150	1,800	13,950
Plat 15, Beauty of Hebron,	2,160	190	2,350	16,200	1,425	17,625

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 11, Clark's, . .	–	–	–	181	28	209
Plat 13, New Queen, . .	–	–	–	203	30	233
Plat 15, Beauty of Hebron,	–	–	–	270	24	294

YIELD OF CROP — *Concluded.*

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

VARIETY.	AMOUNT PER PLAT.			RATE PER ACRE.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . .	1,540	230	1,770	11,550	1,725	13,275
Plat 14, New Queen,. .	1,860	190	2,050	13,950	1,425	15,375
Plat 16, Beauty of Hebron,	2,190	240	2,430	16,425	1,800	18,225

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . .	–	–	–	193	29	222
Plat 14, New Queen,. .	–	–	–	233	24	257
Plat 16, Beauty of Hebron,	–	–	–	274	30	304

An examination of the above tabular statement of the yield of the different varieties of potatoes on trial reveals the following facts: —

1. The yield of potatoes is in every instance larger in case sulphate of potash has furnished the potash of the fertilizer used, than where muriate of potash has served for that purpose.

2. The yield of the three varieties of potatoes on trial, although raised under a corresponding system of cultivation and of manuring, differs seriously. Beauty of Hebron produces nearly one-sixth more in weight than the New Queen variety, and one-third more than the Clark variety.

Plats 12, 17, 18, 19 and 21, which remained in grass in previous years, received as top-dressing, muriate of potash, 200 pounds, and ground bone, 600 pounds, per acre, at an early date in the spring, 1893. The grass was cut June 27 and 28. As the weeds began to infest the plats, the experiment of studying a variety of grasses was closed, and the sod turned under during the month of August. Dry lands

do not favor for any length of time an economical and clean cultivation of the majority of our best grasses.

Yield of First Cut of Grass, May (1893).

Plat 12, Kentucky blue-grass, ... sown Sept. 24, 1889.
Plat 17, Meadow fescue, ... sown Sept. 25, 1887.
Plat 18, Meadow fescue, ... sown Sept. 29, 1890.
Plat 19, Herds grass, ... sown Sept. 25, 1889.
Plat 21, Meadow fescue and herds grass, . . sown Sept. 18, 1891.

	Yield per Plat (Pounds).	Rate per Acre (Pounds).
Plat 12, ...	280	2,100
Plat 17, ...	280	2,100
Plat 18, ...	240	1,800
Plat 19, ...	430	3,225
Plat 21, ...	410	3,075

Value of Grass Fertilizer.

	Per Plat.	Per Acre.
Plats 12, 17, 18, 19, 21, ...	$2 39	$17 93

Some of our observations with grasses upon Field B deserve serious consideration of farmers in our section of the country : —

1. Italian rye grass is less liable to be winter-killed with us than English rye grass.

2. Meadow fescue furnishes a valuable grass, as far as a continuation of a healthy growth during a series of years is concerned, and excels in that respect the herds grass.

3. Grass mixtures as a rule yield larger crops than the same varieties when cultivated by themselves.

Field "B," 1893.

21	Meadow Fescue and Herds Grass.
20	Clark's.
19	Herds Grass.
18	Meadow Fescue.
17	Meadow Fescue.
16	Beauty of Hebron.
15	Beauty of Hebron.
14	New Queen.
13	New Queen.
12	Kentucky Blue-grass and Red Top.
11	Clark's.

Scale, 4 rods to 1 inch.

3. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

Field C.

The area devoted to the above-stated experiment is 189 feet long and 164 feet wide; it is subdivided into six plats of uniform size (88 by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of five feet of unmanured and unseeded yet cultivated land. They are arranged in two parallel rows, running from west to east. Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration.

The entire field occupied by the experiment is nearly on a level. Its past history (since 1885), as far as mode of cultivation and manuring is concerned, is well known. Ground bone and muriate of potash, 600 pounds of the former and 200 pounds of the latter per acre, have been used for more than six years preceding 1891 as general fertilizer. No stable manure of any description has been applied to the field for seven years preceding. General field crops, as grain crops, leguminous plants, potatoes, etc., have been raised upon the grounds in suitable rotation during that period.

The observation with raising garden crops, by the aid of different mixtures of commercial manurial substances here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats 1, 2 and 3 during that of 1892. The difference of the fertilizers applied consisted in the circumstance that different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash

and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others received their nitrogen in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (in our market 95 per cent.). The subsequent tabular statement shows the quantities of the manurial substances applied to the different plats: —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

Beets, cabbages, celery, lettuce, spinach, tomatoes and potatoes have been raised upon the field. One or more of noted varieties of each, as specified in our previous annual reports for 1891 and 1892, have thus far been tried. The field results of 1891 and 1892 have been published without

comment, to enable us to accumulate more facts for the support of our conclusions. Upon a few subsequent pages will be found a description of the management of the experiments during the season of 1893, accompanied by a brief compilation and discussion of all the results thus far obtained.

The entire field was ploughed April 26, and the fertilizer mixtures given in the previous tabular statement were applied broadcast to the plats. The soil was subsequently harrowed and pulverized. All the crops were sown or planted as circumstances advised in rows two and one-half feet apart. Each of the different crops was sown or planted on the same day in all cases. Celery, cabbages, lettuce and tomatoes were raised in hot-beds, and afterwards transplanted to the different plats; while with spinach, beets and potatoes the seed was sown directly upon the plats.

The following order in arranging the different crops was adopted, beginning in each plat at its western end: —

Two rows of spinach, variety New Zealand.
One row of celery, variety Dwarf Golden Heart.
One row of lettuce, variety Hanson.
One row of red cabbage, variety Red Dutch.
Two rows of beets, variety Edmund's Blood Turnip.
Five rows of potatoes, variety Beauty of Hebron.
Two rows of beets, variety Edmund's Blood Turnip.
Three rows of cabbages, variety Fottler's.
Two rows of tomatoes, variety Essex Hybrid.

The order of arrangement of the different crops within each plat was the same in all of them for the same year. They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops.

Order of arrangement of crops in plats: —

1892.
Celery.
Lettuce.
Spinach.
Beets.
Cabbages.
Tomatoes.
Potatoes.

1893.
Spinach.
Celery.
Lettuce.
Red Cabbage.
Beets.
Potatoes.
Beets.
White Cabbage.
Tomatoes.

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three above-stated essential ingredients of plant food: —

Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food: —

4.1 pounds of nitrogen.
3.9 pounds of potassium oxide.
1.9 pounds of phosphoric acid.

The weights and particular stage of growth of the vegetables when harvested control under otherwise corresponding conditions the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one.

The various mixtures of fertilizers used by us in the experiments under discussion provide by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil.

Potatoes were planted May 10; spinach and beets were sown May 15; lettuce and cabbage plants were set out May 15; tomatoes were set out May 29; celery plants were set out June 20. The seeds in every case were taken from the same lot; the young plants were raised under corresponding conditions in the same hot-bed, and a corresponding number transplanted in each plat. All plats were kept clean from weeds and treated in a like manner during the season. The crops were harvested whenever fit for the market. The subsequent tabular statements of the yield of the crops show the date of maturity and the quantity obtained at different dates: —

Yield of Spinach (Variety New Zealand).

Plats.	Pounds.
Plat 1 (two rows), ...	167½
Plat 2 (two rows), ...	182
Plat 3 (two rows), ...	180½
Plat 4 (two rows), ...	57
Plat 5 (two rows), ...	210
Plat 6 (two rows), ...	198½

The seed was sown May 10; the crop was harvested July 12. The low yield of Plat 4 was due to poor germination of the seed.

Yield of Beets (Variety Edmund's Blood Turnip).

Plats.	Pounds.
Plat 1 (four rows), ...	284½
Plat 2 (four rows), ...	382
Plat 3 (four rows), ...	241½
Plat 4 (four rows), ...	371½
Plat 5 (four rows), ...	468½
Plat 6 (four rows), ...	447

The seed was sown May 15, came up May 22, and the roots were harvested October 17.

Yield of Red Cabbage (Variety Red Dutch).

Plats.	Perfect Heads.	Pounds.
Plat 1 (one row; thirty-five plants), ...	29	266¼
Plat 2 (one row; thirty-five plants), ...	29	213½
Plat 3 (one row; thirty-five plants), ...	28	178½
Plat 4 (one row; thirty-five plants), ...	27	180½
Plat 5 (one row; thirty-five plants), ...	27	188½
Plat 6 (one row; thirty-five plants), ...	32	215½

The plants were set out May 15 and harvested October 2.

Yield of White Cabbage (Fottler's).

Plats.	Perfect Heads.	Pounds.
Plat 1 (three rows; thirty-four plants each), .	77	605
Plat 2 (three rows; thirty-four plants each), .	77	597¼
Plat 3 (three rows; thirty-four plants each), .	87	600¾
Plat 4 (three rows; thirty-four plants each), .	70	674¾
Plat 5 (three rows; thirty-four plants each), .	87	711
Plat 6 (three rows; thirty-four plants each), .	86	730¾

The plants were set out May 15; they were harvested September 1 to October 2.

Yield of Potatoes (Variety Beauty of Hebron).

Plats.	Pounds.		
	Marketable.	Small.	Total.
Plat 1 (five rows), ...	314	86	400
Plat 2 (five rows), ...	458	62	520
Plat 3 (five rows), ...	309	81	390
Plat 4 (five rows), ...	455	70	525
Plat 5 (five rows), ...	462	58	520
Plat 6 (five rows), ...	475	105	580

The potatoes were planted May 10, one bushel of seed being used per plat; they were dug August 19.

Yield of Celery (Variety Dwarf Golden Heart).

Plats.	Perfect Heads	Pounds.
Plat 1 (one row; eighty plants), . . .	*	*
Plat 2 (one row; eighty-four plants), . .	*	*
Plat 3 (one row; eighty-four plants), . .	*	*
Plat 4 (one row; eighty-four plants), . .	*	*
Plat 5 (one row; eighty-four plants), . .	*	*
Plat 6 (one row; eighty-four plants), . .	*	*

* Practically a failure on account of the drought.

The plants were set out June 20.

Yield of Lettuce (Variety Hanson).

Plats.	Perfect Heads.	Pounds.
Plat 1 (one row; seventy-five plants), . .	65	37½
Plat 2 (one row; seventy-five plants), . .	67	40
Plat 3 (one row; seventy-three plants), . .	68	45
Plat 4 (one row; seventy-seven plants), . .	71	62½
Plat 5 (one row; seventy-five plants), . .	73	75
Plat 6 (one row; seventy-five plants), . .	67	52

The plants were set out May 15; they were harvested July 6.

Yield of Tomatoes (Variety Essex Hybrid).

Date of Harvesting.	Plats. 1.	2.	3.	4.	5.	6.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
August 8 (matured),	22	20	15½	12¼	9	15½
August 11 (matured),	25	18½	24½	24½	26½	18
August 16 (matured),	38	35	48	55¼	52	49
August 21 (matured),	36½	42½	25¼	49	48¼	63
August 25 (matured),	32½	46½	47	53	53½	65½
August 30 (matured),	45	80	73	72	100¾	57
September 1 (matured),	16½	65½	61	86½	85½	32¾
September 5 (matured),	19	47	77	95	112	60¼
September 11 (matured),	26	83	89	62½	122½	39
September 15 (matured),	19½	111	86½	71	92	19½
September 20 (matured),	26½	111½	93¼	100½	154¾	35
Total weight of matured tomatoes,	306½	660½	640	681½	756¼	437½
September 23 (green),	56½	214	167¼	137	222½	81
Total weight of tomatoes, both matured and green,	363	874½	807¼	818½	978¾	515½

There were two rows in each plat, and from twenty-two to twenty-three plants in each row. The plants were set out from the hot-bed May 29; they came in bloom June 16, and began to form tomatoes June 29.

Potatoes (Variety Beauty of Hebron).

Plats.	Pounds. 1891.	1892.	1893.
Plat 1 (five rows),	–	585	400
Plat 2 (five rows),	–	665	520
Plat 3 (five rows),	–	545	390
Plat 4 (five rows),	735	640	525
Plat 5 (five rows),	780	740	520
Plat 6 (five rows),	–	435	580

Tomatoes (Variety Essex Hybrid).

Plats	Pounds.		
	1891.	1892.	1893.
Plat 1 (two rows),	–	464	339
Plat 2 (two rows),	–	572	874½
Plat 3 (two rows),	–	466	807
Plat 4 (two rows),	641	515	783
Plat 5 (two rows),	647	593	928½
Plat 6 (two rows),	–	332	515

Lettuce (Variety Hanson).

Seventy Plants.	1892.	1893.
Plat 1 (one row),	41½	40½
Plat 2 (one row),	36	42
Plat 3 (one row),	43	46
Plat 4 (one row),	76	62
Plat 5 (one row),	60	70
Plat 6 (one row),	36	55

Cabbages (Variety Fottler's).

Sixty-two Plants.	1892.	1893.
Plat 1 (two rows),	534	490
Plat 2 (two rows),	762	484
Plat 3 (two rows),	576	428
Plat 4 (two rows),	458	595
Plat 5 (two rows),	674	508
Plat 6 (two rows),	586	527

Spinach (Variety New Zealand).

Plats.	1892.	1893.
Plat 1 (two rows), ...	192	167½
Plat 2 (two rows), ...	233	182
Plat 3 (two rows), ...	202	180½
Plat 4 (two rows), ...	230	–
Plat 5 (two rows), ...	232	210
Plat 6 (two rows), ...	134	198½

Beets (Variety Edmund's Blood Turnip).

Plats.	1892.	1893.
Plat 1 (four rows), ...	350	284½
Plat 2 (four rows), ...	345	382
Plat 3 (four rows), ...	515	241½
Plat 4 (four rows), ...	455	371½
Plat 5 (four rows), ...	509	468½
Plat 6 (four rows), ...	495	447

An examination of the preceding results shows the serious influence of the dry weather throughout a large part of the past season, as affecting the total yield of the different plats as compared with each other. Potatoes, cabbages, beets and spinach show a marked decrease in total yield over last year, while lettuce and tomatoes show a considerably larger yield. The relative yield of the plats for both seasons is only slightly affected.

Field C, Eastern Portion.

The portion of Field C east of the plats is 183 by 131 feet, and contains .55 acre. The fertilizer applied consisted of 300 pounds of fine-ground bone and 100 pounds

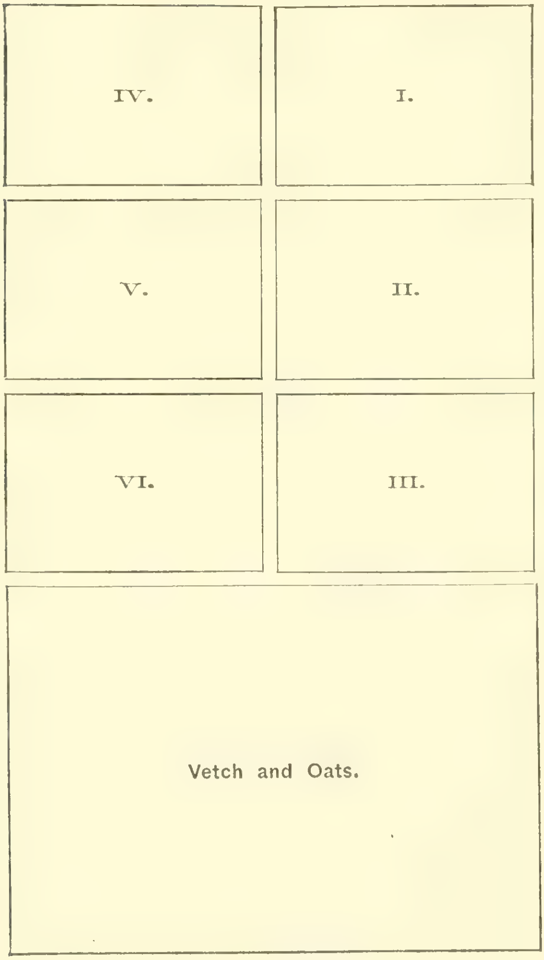
of muriate of potash, applied broadcast. On May 8 the field was sown to vetch and oats, 25 pounds of vetch and 2½ bushels of oats being used for seed. The crop made an even and rapid growth. About two-fifths of the crop was used for green fodder July 6 to 18. The remainder was cut as hay. The area cut for green fodder yielded 5,053 pounds, or 21,800 pounds per acre; that cut as hay weighed 1,750 pounds, or 5,469 pounds per acre. On July 28 the land was again ploughed. A fertilizer mixture, composed of 100 pounds of nitrate of potash and 300 pounds of ground bone, was applied broadcast and harrowed in. August 4 the field was sown to buckwheat; this came in bloom September 1. The crop began to be cut for green fodder when in full bloom, September 11, and the cutting was completed September 29. The yield of green fodder was 3,870 pounds, or 7,036 pounds of green fodder per acre.

Analysis of Vetch and Oats (Green).

Moisture at 100° C.,	79.16
Dry matter,	20.84
	100.00

Analysis of Dry Matter.

Crude ash,	8.80
" cellulose,	30.34
" fat,	3.90
" protein,	13.27
Nitrogen-free extract matter,	43.69
	100.00



Field "C," 1893.

Scale, 4 rods to 1 inch.

4. Experiments with a Variety of New Forage Crops (1893).

Field D.

This field has been used for the past two years for the raising of a variety of reputed annual and perennial fodder crops, in the majority of cases new to our section of the country, to study their adaptation to our climate and soil. Some of them have since been raised on a larger scale successfully and profitably for the support of our dairy stock.

The field is 328 feet long and 70 feet wide, covering an area of 22,960 square feet, or .527 acre. The land was ploughed April 24 and May 10. The fertilizer used consisted of a mixture of 600 pounds of ground bone and 200 pounds of muriate of potash, which was applied broadcast and harrowed in before seeding. The different crops were planted in rows two and one-half feet apart, and were kept free from weeds throughout the season. They were arranged in the field during the past season in the following order, beginning at the west end: —

White lupine (*Lupinus albus*).
Yellow lupine (*Lupinus lutens*).
Prickley comfrey (*Symphytum officinale*).
Forest pea or flat pea (*Lathyrus sylvestris*).
Late-maturing soja bean (*Soja hispida*).
Kidney vetch (*Anthyllis vulneraria*).
Early-maturing white soja bean (*Soja hispida*).
Sainfoin (*Onobrychis sativa*).
Early-maturing black soja bean (*Soja hispida*).
Cow-pea (*Dolichos sinensis*).
Serradella (*Ornithopus sativus*).
Spring vetch (*Vicia sativa*).
Bokhara clover (*Melilotus alba*).
Horse bean (*Vicia faba*).
Kaffir corn.
Common buckwheat (*Fagopyrum esculentum*).
Japanese buckwheat (*Fagopyrum esculentum*).
Silver-hull buckwheat (*Fagopyrum esculentum*).
Summer rape (*Brassica Napus*).
Carrots (*Daucus carota*).

White lupine (*Lupinus alba*), four rows. The seed was sown May 19. The young plants broke ground May 29;

they were considerably affected by the drought of July and August. The plants proved to be of a late variety, blossoming the latter part of September. The seed was bought of J. M. Thorburn, New York City, at eleven cents per pound.

Yellow lupine (*Lupinus lutens*), four rows. The seed was sown May 19 and came up May 29. The plants began to blossom July 29, pods commenced forming August 5, and ripened seed throughout the month of September. Large, well-formed tubercles were found on the roots of this, as well as on those of the preceding variety.

Both varieties of lupine deserve a high recommendation for green manuring, having served us well for that purpose.

Prickley comfrey (*Symphytum officinale*), one row. The roots remained in the ground from last year, and wintered well during the winter of 1892–93. The plants started into growth early in the spring, and blossomed June 13; July 24 they were cut. The plants were again cut early in the fall. Both cuttings showed a liberal, vigorous growth. This fodder plant offers but little inducement for home cultivation when compared with many of our annual leguminous plants.

Forest pea or flat pea (*Lathyrus sylvestris*), three rows. The roots remained in the ground from last year; they were partially winter-killed. The crop blossomed June 24 and was cut July 27, at which time the growth was large and rank. A second growth was cut during the fall. Our results thus far are but little encouraging.

Late-maturing soja bean (*Soja hispida*), two rows. The seed was sown May 19, the young plants appearing above the ground May 29. They made a vigorous and leafy growth, blossoming September 15. This variety is apparently of much less feeding value than the earlier blooming varieties. The seed was obtained of J. M. Thorburn of New York City, at eight cents per pound.

Kidney vetch (*Anthyllis vulneraria*), four rows. The roots remained in the ground from last year, and wintered very well. The plants blossomed for the first time since seeding June 13; they were cut July 24. No second cut was obtained. It is a very attractive plant when in bloom. Seed was bought of D. Landreth & Sons, Philadelphia, Pa.

Early-maturing white soja bean (*Soja hispida*), ten rows.

The seed was sown May 19 and came up May 29. The plants began to blossom July 17; they were cut August 19. The seed was of our own raising. This variety has served us well for several years as hay and as ensilage (see previous reports).

Sainfoin (*Onobrychis sativa*), five rows. The crop wintered well from last year. The plants began to blossom June 5 and were cut July 27. A second growth was produced. The seed was bought of Henry Nungesser, New York City, at six cents per pound.

Early-maturing black soja bean (*Soja hispida*), five rows. The seed was sown May 19 and the young plants broke ground May 29. They came into bloom July 17 and were cut August 19. The only marked difference between the black and the white varieties consists in the color of the seeds and of more foliaceous growth in the case of the black variety. It is a valuable fodder plant and stands our climate well. The seed used was of our own raising.

Cow-pea (*Dolichos sinensis*), five rows. The seed was sown May 19, the young plants appearing above ground May 26. August 26 the plants blossomed and were cut for fodder. Most varieties of this plant do not produce ripe seed with us. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa.

Serradella (*Ornithopus sativus*), five rows. The seed was sown May 19 and came up May 29; blossoms appeared July 11 and the crop was cut for fodder August 14. The growth was very rank and heavy. The crop has supplied us for years with a good green fodder. The seed was obtained of Henry Nungesser, New York City, at eight cents per pound.

Spring vetch (*Vicia sativa*), five rows. The seed was sown May 19, the plants appearing May 26 and beginning to blossom July 11. August 4 the growth was cut for fodder. Vetch with oats has furnished us for several years an excellent material for green fodder and hay. The seed was obtained of Henry Nungesser, New York City, at eight cents per pound.

Bokhara clover (*Melilotus alba*), five rows. The seed was sown May 19. The plants appeared above ground May 26, and were cut August 12, at which time there were no signs of blooming. There was a small second growth. The plant with us is apt to grow rank and too woody to furnish an

acceptable fodder article for any length of time. The seed was bought of Henry Nungesser, New York City, at twenty cents per pound.

Horse bean (*Vicia faba*), five rows. The seed was sown May 19 and came up May 29. The plants began to bloom July 11. During the summer a blight attacked some of the leaves, turning them black. The plant furnishes a good green fodder when raised in connection with oats or barley and vetch. The seeds are very nutritious. The plants were cut September 28. The seed was obtained of J. M. Thorburn & Sons, New York, N. Y., at nine cents per pound.

Kaffir corn, one row. The seed was sent on for trial from Lawrence, Kan. It was planted May 19 and began to come up May 30; August 26 the plants began to head out. They reached a height of five feet, and were characterized by slender but very leafy stems. No great agricultural merit could be obtained in our section of the country, as the plant does not mature.

Common buckwheat (*Fagopyrum esculentum*), five rows. The seed was sown May 19. The plants broke ground May 27 and came in bloom June 24. This buckwheat made a smaller growth than either of the others. It was cut for fodder July 31. We have used common buckwheat with good results as second crop after vetch and oats or summer grain, to serve as green fodder for cattle during the latter part of the season.

Japanese buckwheat (*Fagopyrum esculentum*), five rows. The seed was sown May 19 and came up May 25. The plants came in blossom June 24. The growth was very heavy, the leaf development being greater than in the case of either of the two other varieties of buckwheat. The plants were cut for fodder, when beginning to form seed, on August 2. This variety deserves the serious attention of farmers as a substitute for our common buckwheat. The seed was obtained of J. M. Thorburn, New York, N. Y., at six cents per pound.

Silver-hull buckwheat (*Fagopyrum esculentum*), five rows. The seed was sown May 19. The plants broke ground May 27 and came into bloom June 24. July 29 they were cut for fodder. The seed was obtained of J. M. Thorburn, New York City, at six and one-fourth cents per pound.

Summer rape (*Brassica Napus*), five rows. The seed was sown May 19 and came up May 25. The plants were cut for fodder August 7, at which date they showed no signs of blooming. A second growth was cut early in the fall. Both cuttings showed a healthy and abundant growth. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa.

Carrots (*Daucus carota*). The seed was sown June 1, appearing above ground June 10. The plat (.155 acres) was weeded and hoed July 10. The crop was harvested November 2. Yield, 5,540 pounds, or 13–14 tons per acre.

Analyses of Crops raised upon Field D (1893).

[I., common buckwheat (*Fagopyrum esculentum*): dried; cut when in bloom. II., silver-hull buckwheat (*Fagopyrum esculentum*): dried; in bloom. III., Japanese buckwheat (*Fagopyrum esculentum*): dried; in bloom. IV., summer rape (*Brassica Napus*): dried; cut before blooming. V., prickley comfrey (*Symphytum officinale*): second growth.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.50	8.91	5.71	11.13	86.79
Dry matter,	91.50	91.09	94.29	88.87	13.21
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	14.63	10.17	12.36	18.25	21.12
" cellulose,	19.35	27.07	36.02	18.15	11.03
" fat,	3.04	2.55	2.22	3.79	2.06
" protein,	17.90	12.22	10.80	14.43	17.49
Nitrogen-free extract matter,	45.08	47.99	38.60	45.38	48.00
	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	8.500	8.910	5.720	11.130	86.790
Dry matter contains: —					
Nitrogen,	2.866	1.954	1.727	2.310	2.800
Potassium oxide,	3.504	2.612	3.521	5.254	5.745
Calcium oxide,	–*	2.514	3.625	4.153	2.263
Magnesium oxide,	–*	.577	.446	.587	.310
Phosphoric acid,	.547	.944	.903	.643	.870
Insoluble matter,	–*	.507	.400	.781	–*

* Not determined.

Analyses of Crops raised upon Field D (1893) — Continued.

[I., yellow lupine (*Lupinus lutens*) : in bloom. II., white lupine (*Lupinus albus*) : in bloom. III., sainfoin (*Onobrychis sativus*) : dried ; in bloom. IV., Bokhara clover (*Melilotus alba*) : dried ; in bloom. V., serradella (*Ornithopus sativa*) : green ; in bloom. VI., kidney vetch (*Anthyllis vulneraria*) : second growth ; in bloom.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	86.05	85.35	12.17	7.43	82.41	80.85
Dry matter,	13.95	14.65	87.83	92.57	17.59	19.15
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	11.14	5.03	8.54	7.66	10.99	13.28
" cellulose,	27.10	31.18	26.95	30.57	30.08	14.94
" fat,	1.87	2.41	4.49	3.32	2.41	3.51
" protein,	17.84	18.71	17.70	13.37	15.01	18.43
Nitrogen-free extract matter,	42.05	42.67	42.27	45.08	41.13	49.84
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	85.05	85.350	12.170	7.430	82.410	80.850
Dry matter contains : —						
Nitrogen,	2.662	2.993	2.880	2.133	2.632	2.939
Potassium oxide,	2.949	1.730	2.299	1.979	2.414	1.754
Calcium oxide,	1.926	3.070	1.320	1.927	2.636	4.736
Magnesium oxide,	.328	.730	.489	.374	.384	.287
Phosphoric acid,	.603	.350	.854	.602	.804	.443
Insoluble matter,	1.076	.900	.535	.061	.557	.809

Analyses of Crops raised upon Field D (1893) — Concluded.

[I., flat pea (*Lathyrus sylvestris*) : in bloom. II., flat pea (*Lathyrus sylvestris*) : second growth. III., common vetch (*Vicia sativa*) : in bloom. IV., horse bean (*Vicia faba*) : with pods forming. V., soja bean (*Soja hispida*) : with pods forming. VI., cow-pea (*Dolichos sinensis*) : with pods forming.

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C., .	8.96	78.62	9.90	84.83	76.42	80.31
Dry matter, . .	91.10	21.38	91.10	15.17	23.58	19.69
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash, . . .	9.39	8.91	8.24	5.75	7.74	9.29
" cellulose, .	31.76	20.38	30.27	28.17	26.47	21.67
" fat, . . .	1.78	5.00	2.50	2.31	4.84	4.06
" protein, . .	24.04	30.65	15.09	16.68	16.45	17.05
Nitrogen-free extract matter, . . .	33.03	35.06	43.80	47.09	44.50	47.93
	100.00	100.00	100,00	100.00	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C., .	8.96	78.62	9.90	84.83	76.42	80.31
Dry matter contains : —						
Nitrogen, . .	3.846	4.904	2.414	.675	2.476	1.796
Potassium oxide, .	2.572	2.100	3.010	1.370	1.151	1.042
Calcium oxide, .	1.791	1.412	1.860	1.370	2.945	2.964
Magnesium oxide,	.498	.411	–*	.620	1.257	.756
Phosphoric acid, .	.900	.655	.810	.330	.711	.579
Insoluble matter, .	2.011	1.155	.560	2.040	–*	.914

* Not determined.

Spring Vetch (*Vicia sativa*).
July, 1891. Pods forming.

Early-maturing Soja Bean (*Soja hispida*).

September, 1893. With pods formed.

Flat Pea (*Lathyrus sylvestris*).

August, 1893. In bloom.

KIDNEY VETCH (*Anthyllis vulneraria*).

August, 1893. In bloom.

Field "D." — Arrangement of Crops raised.

W

1892.

- Artichoke.
- Prickley Comfrey.
- Pyrethrum.
- Forest Pea.
- Stachy's Tubers.
- Kidney Vetch.
- Winter Rape.
- Sainfoin.
- Yellow Trefoil.
- Spring Vetch.
- Bokhara Clover.
- Summer Rape.
- Horse Bean.
- Serradella.
- Soja Bean.
- Cow-pea.
- Jackson Wonder Bean.
- Blue Lupine.
- White Lupine.
- Yellow Lupine.
- Silver-hull Buckwheat.
- Japanese Buckwheat.
- Common Buckwheat.

1893.

- Minnesota Corn.
- White Lupine.
- Yellow Lupine.
- Prickley Comfrey.
- Pyrethrum.
- Forest Pea.
- Late Soja Bean.
- Kidney Vetch.
- Early White Soja Bean.
- Sainfoin.
- Early Black Soja Bean.
- Cow-pea.
- Serradella.
- Spring Vetch.
- Bokhara Clover.
- Horse Bean.
- Kaffir Corn.
- Common Buckwheat.
- Japanese Buckwheat.
- Silver-hull Buckwheat.
- Summer Rape.
- Carrots.

E

Scale, 50 feet to 1 inch.

Scale, 4 rods to 1 inch.

Field E (Rye).

This field is 260 feet long and 48 feet wide, containing .286 acre. In September of 1892 the field was ploughed and the following fertilizer mixture applied: 200 pounds of fine-ground bone and 70 pounds of high-grade sulphate of potash. The field was then sown to rye and winter rape, two-thirds of a bushel of rye and ten pounds of rape being used for seed. Both the rye and the rape came up and made a fair fall growth. The rye wintered well, but the rape entirely winter-killed.* The rye headed out May 29 and was cut July 12.

Yield of Rye.

	Pounds.
Grain, ...	336
Straw and chaff, ...	1,243

Rate per Acre.

Grain, ...	1,175
Straw and chaff, ...	4,246

* Judging from the experiment, the seed sown proved to be summer rape instead of winter rape, as supposed.

5. Field Experiments with Different Commercial Phosphates to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates.

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each twenty-one feet wide, with a space of eight feet between adjoining plats.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	–	–	–	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9:04	6.26

The following fertilizer mixtures have been applied annually to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Potatoes were raised upon the plats in 1890; in 1891 winter wheat was employed (for details see ninth annual report); in 1892 serradella was the crop experimented with (see tenth annual report).

1893. — The field was ploughed April 29. May 6 the fertilizers were applied broadcast to the various plats, and the land was afterwards thoroughly harrowed and pulverized. May 20 corn, variety "Pride of the North," was planted in hills, eighteen quarts being used. The crop was cultivated three times, and hoed twice during the months of June and July. The corn came in bloom August 1 and was cut September 8. It remained in the field until October 10–13, when the ears of corn were picked. During the entire season Plat 1 appeared to make a larger and more rapid growth than any of the other plats.

Height of Plants during the Season.

Plats.	July 3.	July 10.	July 17.	July 24.	July 31.	Aug. 7.
Plat 0 (inches), . .	10	12	16	23	25	39
Plat 1 (inches), . .	20	32	44	54	73	86
Plat 2 (inches), . .	13	20	26	40	63	80
Plat 3 (inches), . .	10	14	19	31	46	69
Plat 4 (inches), . .	11	15	23	41	57	79
Plat 5 (inches), . .	13	17	27	45	55	81

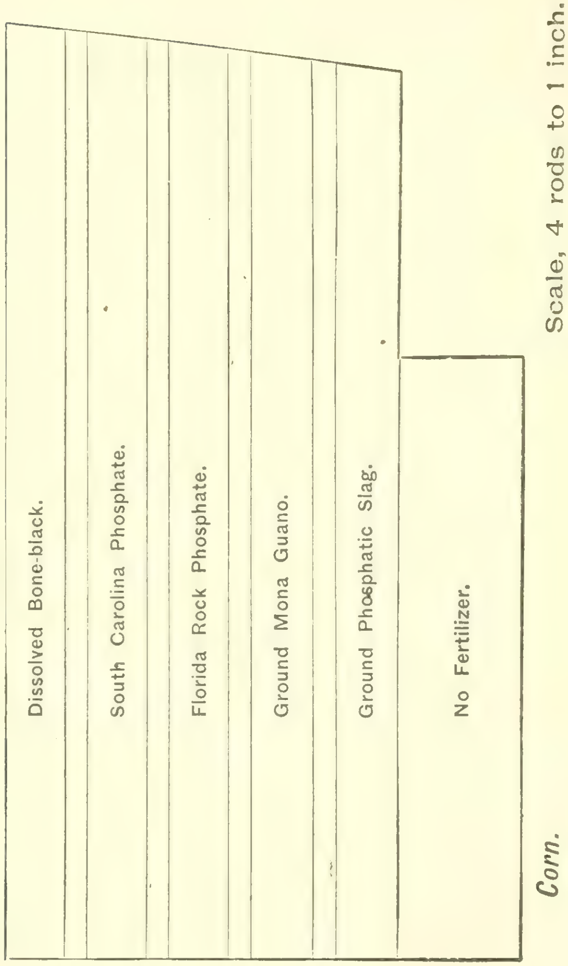
Yield of Crop.

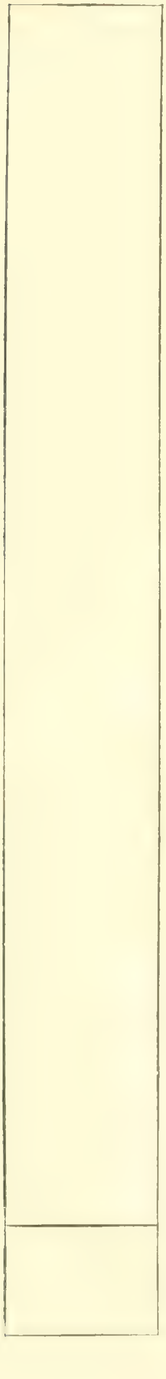
Plats.	Amount per Plat.			Rate per Acre.		
	Ears.	Stover.	Total.	Ears.	Stover.	Total.
Plat 0, ...	–	650	650	–	3,660	3,660
Plat 1, ...	470¼	1,190	1,660¼	3,195	7,985	11,180
Plat 2, ...	571	810	1,381	3,791	5,378	9,169
Plat 3, ...	432	915	1,347	2,834	6,002	8,836
Plat 4, ...	579½	890	1,469½	3,767	5,785	9,552
Plat 5, ...	542¼	780	1,322¼	3,486	5,015	8,501

Relative Ratio of Ears to Stover.

Plat 1, ...	1 : 2.5
Plat 2, ...	1 : 1.4
Plat 3, ...	1 : 2.1
Plat 4, ...	1 : 1.5
Plat 5, ...	1 : 1.4

Field "F," 1893.


Dissolved Bone-black.
South Carolina Phosphate.
Florida Rock Phosphate.
Ground Mona Guano.
Ground Phosphatic Slag.
No Fertilizer.
Corn.
Scale, 4 rods to 1 inch.



Field "G," 1893.

Scale, 6 rods to 1 inch.

6. Experiments with Corn.

Field G.

This field is 700 feet long and 75 feet wide; area, 52,500 square feet, or $1\frac{1}{5}$ acres. The land is nearly level and the soil a loam several feet in depth.

May 1 barn-yard manure was applied to the field at the rate of ten tons per acre. A few days later the field was ploughed, harrowed and prepared for planting. The southern end of the field for a distance of fifty feet was planted to artichokes. The remainder of the field was planted to corn, variety "Pride of the North." The corn was planted in hills May 20, sixteen quarts of seed being used. The crop was cultivated June 5 and June 23. August 1 the stalks began to bloom. The crop was cut September 9. Owing to the wet condition of the soil on a portion of the field, the corn on that portion (108 feet of the length of the field) was used for green fodder. The remainder of the crop (.92 acre) stood in the field until October 20, when it was husked.

Yield of Crop (per Acre).

	Pounds.
Ears, ...	2,920
Stover, ...	5,917
Total, ...	8,837

The artichokes were planted May 20 and cultivated throughout the season with the corn. They blossomed late in September. The roots will remain in the ground over winter and are to be dug in the spring.

7. Field Experiments to compare the Effect of Home-made Mixed Stable Manure, of Unleached Wood Ashes and of Various Mixtures of Commercial Fertilizing Materials on the Yield of Some Prominent Farm Crops, when applied as Manure under Otherwise Fairly Corresponding Conditions (1888–94).

East Field.

The land used for these observations covers an area of from seven to eight acres, and is located along the east side of the farm of the station. On its western termination it borders on a meadow in fair condition, and on its eastern side it is separated from a natural thrifty grove by a private road from thirty-five to forty feet wide.

The soil consists of a somewhat sandy loam, with indications of light springs in various parts of the field. The more prominent springs are connected by drain pipes with the main drain of the adjoining meadow since the experiment began.

The entire field slopes gently and quite uniformly from east to west. Corn and grasses represent in the main the crops raised upon the ground in years preceding 1887.

The inferior yield and character of the crops of later years raised upon the land pointed towards an indifferent management, as far as the selection of crops and of manure is concerned. To destroy weeds and other objectionable local growths, it became advisable to introduce a thorough system of drill cultivation.

In the autumn of 1887 the sod which covered the entire area was turned under by ploughing, and subsequently, by a repeated use of a wheel harrow, was thoroughly broken up. One ton of unleached wood ashes (per acre), applied broadcast and slightly ploughed in before the close of the season, served as manure for the coming year (1888).

The succeeding spring, after a thorough mechanical preparation of the soil by ploughing and harrowing, the following crops were planted: potatoes, barley, oats and corn.

They were sown in rows running along the sloping grounds from north to south, to secure favorable conditions for an advantageous and liberal use of a horse cultivator in the interest of clean cultivation.

The crops raised during that season showed a fairly uniform state of productiveness of the entire field here under discussion.

1889. — The field experiments with different manures, which are the special subject of this chapter, began during the spring of that year.

The lands previously described are divided by a grass road into two parts, a north and a south field. The former occupies a space of from five to six acres and the latter three to four acres. Each of these fields, running from north to south, was subsequently subdivided into five plats, which were kept separate from each other by a space of land fourteen feet wide, running along the entire length of each plat from east to west. The spaces between adjoining plats were cultivated and planted in connection with the main plats. They received, however, at no time manure of any description during the entire experiment.

The crops selected for the experiment were in all cases planted in the same manner across the five plats set apart for the observation. They occupied in every case, as far as the same crops are concerned, the same area. The mechanical preparation of the soil was alike in case of the same crop; the same statement applies to the special treatment, as cultivating, etc., during the growing season, and to the mode of harvesting.

The difference in the treatment of the five plats was entirely confined to a different mode of supplying plant food to the crops raised; each plat was treated year after year in the following manner (1889 to 1894): —

Fertilizer applied Each Year from 1889 to 1894.

Plat I. — Home-made mixed barn-yard manure, 18,000 pounds (rate of 10 tons per acre).

Plat II. — Wood ashes, 1,800 pounds (rate of 1 ton per acre).

Plat III. — No fertilizer.

Plat IV. — Ground bone, 540 pounds (rate of 600 pounds per acre); muriate of potash, 180 pounds (rate of 200 pounds per acre).

Plat V. — Ground bone, 540 pounds (rate of 600 pounds per acre); sulphate of potash and magnesia, 360 pounds (rate of 400 pounds per acre).

Composition of Fertilizers used.

	Per Cent.		
	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Barn-yard manure,	.568	.688	.523
Wood ashes,	–	1.45	7.63
Muriate of potash,	–	–	46.00
Sulphate of potash and magnesia,	–	–	24.32
Fine-ground bone,	4.02	22.96	–

The basis of the valuation of the essential fertilizing ingredients contained in barn-yard manure is the same as adopted in case of feed stuffs, viz.: —

	Cents per Pound.
Nitrogen,	$17\frac{1}{2}$
Phosphoric acid,	5
Potassium oxide,	$5\frac{1}{2}$

Market Cost at Amherst of Fertilizers used.

	Cost per Plat.	Cost per Acre.
Plat I.,	$29 34	$32 60
Plat II.,	9 90	11 00
Plat IV.	11 16	12 40
Plat V.,	14 83	16 48

The barn-yard manure was applied broadcast in the fall and ploughed in early in the spring. The wood ashes and commercial fertilizers were applied broadcast and harrowed

in before seeding down. The amount of barn-yard manure (plat I.) used is an exceptional one, for the purpose of securing its highest effect. The annual amount of the remaining fertilizers in case of plats II., IV. and V. is within customary farm practice.

Name of Crop raised (1889).	Entire Area occupied by the Crop.	Area occupied by the Crop in Each Plat.
	Acres.	Acres.
Barley (in drills two feet apart), ...	.88	.158
Barley (broadcast), ...	.81	.146
Dent corn, "Pride of the North" (rows three feet three inches apart), ...	3.31	.596

Amount of Seed used per Acre.

	Pounds.
Barley, in drills, ...	57
Barley, broadcast, ...	70
Dent corn, "Pride of the North" (rows three feet three inches apart), ...	27

Yield of Crops in Each Plat, calculated for One Acre.

[Pounds.]

Whole Crop.	Plat I.	Plat II.	Plat III.	Plat IV.	Plat V.
Barley, in drills (matured), .	3,006	3,753	2,975	3,500	2,405
Barley, broadcast (matured), .	2,192	2,459	2,192	2,959	2,658
Dent corn (kernels glazed), .	18,875	19,246	15,461	20,735	19,644

Drilled barley when cut contained 44.4 per cent. of solid matter; corn when cut contained 25.4 per cent. of solid matter.

Conclusion. — The generally fair state of productiveness of the lands at the beginning of the experiment shows itself in the fact that the unfertilized plat (III.) yields but little less than some of the fertilized plats.

1890. — The system of manuring and the general treatment of the soil was the same as in the preceding year.

Name of Crop raised (1890).	Entire Area occupied by Crop.	Area occupied by Crop in Each Plat.
	Acres.	Acres.
Vetch and oats (broadcast), ...	.88	.158
Scotch tares (in drills three feet three inches apart), ...	.81	.146
Soja bean (in drills three feet three inches apart),	2.08	.374

Amount of Seed used per Acre.

Vetch and oats, 80 pounds of oats and 40 pounds of vetch.
Scotch tares in drills, ... 47 pounds.
Soja bean in drills, ... 50 pounds.

Yield of Crops in Each Plat, calculated for One Acre.

[Pounds.]

Whole Crop.	Plat I.	Plat II.	Plat III.	Plat IV.	Plat V.
Vetch and oats (green, blooming when cut), ...	11,924	8,266	7,190	10,355	11,411
Scotch tares (hayed, blooming when cut), ...	2,842	3,322	1,884	3,219	3,664
Soja bean (green, blooming when cut), ...	9,037	9,556	7,313	10,603	10,305

Vetch and oats when cut contained 20 per cent. dry matter.
Soja bean when cut contained 22 per cent. dry matter.
Scotch tares when cut and dried contained 80 per cent. dry matter.

Conclusions.

1. The effect of the commercial manures applied in case of plats IV. and V. on the yield of crops compares very favorably with that of barn-yard manure (plat I.).

2. Wood ashes have given in our case on the whole quite satisfactory results.

3. The presence in the soil of a liberal amount of organic vegetable matter in all plats, due to the sod turned under (1888–89), has in all probability brought the highest possible manurial effect of wood ashes and commercial fertilizers (plats II., IV., V.).

4. The sulphate of potash-magnesia has given us, in case of leguminous plants, in two out of three cases a better yield of crops than the muriate of potash. The crops are in the majority of cases leguminous plants (clover-like plants).

5. The decline in the yield of the unfertilized as compared with that of the fertilized plats becomes more apparent than in the preceding year.

1891. — The system of manuring and the general treatment of the soil corresponded to that in preceding years.

NAME OF CROP RAISED (1891).	Entire Area occupied by the Crop.	Area occupied by the Crop in Each Plat.
	Acres.	Acres.
Barley (in drills two feet apart), ...	1.68	.302
Oats (in drills two feet apart), ...	.92	.165
Oats (broadcast), ...	1.19	.214

Amount of Seed used per Acre.

	Pounds.
Barley, in drills, ...	68
Oats, in drills, ...	65
Oats, broadcast, ...	78

Yield of Crops in Each Plat, calculated for One Acre.

[Pounds.]

		Plat I	Plat II.	Plat III.	Plat IV.	Plat V.
Barley, in drills,	straw, . . .	2,000	1,952	1,526	2,179	2,219
	grain, . . .	1,113	1,060	692	1,133	1,043
	Total, . . .	3,113	3,012	2,218	3,312	3,262
Oats, in drills,	straw, . . .	2,263	2,558	1,636	2,878	2,448
	grain, . . .	1,248	1,170	729	1,333	1,188
	Total, . . .	3,511	3,728	2,365	4,211	3,636
Oats, broadcast,	straw, . . .	3,192	2,481	1,729	3,140	2,977
	grain, . . .	897	696	467	1,065	991
	Total, . . .	4,089	3,177	2,196	4,205	3,968

Weight of Straw and Grain reduced to a Percentage (1891).

		Plat I.	Plat II.	Plat III.	Plat IV.	Plat V.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Barley, in drills,	straw, . . .	64	65	69	66	68
	grain, . . .	36	35	31	34	32
Oats, in drills,	straw, . . .	64	69	69	68	67
	grain, . . .	36	31	31	32	33
Oats, broadcast,	straw, . . .	78	78	79	75	75
	grain, . . .	22	22	21	25	25

An examination of the above-stated results leads to the following conclusions: —

1. Seeding in drills has in every instance given a larger percentage of grain than seeding broadcast.

2. The yield of the crop on the fertilized plats exceeds as a rule about thirty-three per cent. that of the crop obtained on the unfertilized plat.

3. The results obtained by the aid of commercial manures applied to plats IV. and V. compare very favorably with those obtained with barn-yard manure or wood ashes.

4. Muriate of potash as potash source of plant food in case of grain crops as a rule leads in yield of crops the sulphate of potash-magnesia.

1892. — The system of manuring was the same as in preceding years. The general treatment of the soil was alike in all plats.

Name of Crop raised (1892).	Entire Area occupied by the Crop.	Area occupied by the Crop in Each Plat.
	Acres.	Acres.
Canada peas and oats (broadcast), . . .	.88	.158
Soja bean (in drills two and a half feet apart),	.81	.146
Dent corn, "Pride of the North" (in drills two and a half feet apart, two feet apart in row), .	3.31	.596

Amount of Seed used per Acre.

Canada peas, 2 bushels, and oats, 4 bushels.
Soja beans, ... 60 pounds.
Dent corn, ... 14 quarts (26 to 28 pounds).

Yield of Crop in Each Plat, calculated for One Acre.

[Pounds.]

	Plat I.	Plat II.	Plat III.	Plat IV.	Plat V.
Canada peas and oats (green, in full bloom), ...	–	13,861	11,291	15,101	14,829
Soja bean, ...	*	*	*	*	*
Dent corn — Kernels glazing, . .	25,034	20,025	13,674	†	†
Dent corn — Stover, ...	–	–	–	8,121	8,020
Dent corn — Ears, ...	–	–	–	1,557	1,200

* Not weighed, being fed during August and September.
† Cut for silo.

Dent corn when cut for the silo (kernels glazed but soft) contained from 26 to 28 per cent. of dry vegetable matter; peas and oats when cut (in bloom) contained from 15 to 16 per cent. of dry vegetable matter. As the vetch and oats raised upon the same plats in 1890 contained 20 per cent. of dry matter when cut, it will be seen that this crop under fairly corresponding conditions compares well with that of Canada peas and oats, as far as their yield is concerned.

Analyses of: —

1. Vetch and oats (1890).
2. Canada peas and oats (1892).
3. Early-maturing soja bean (when blooming) (1892).

	Per Cent.		
	1.	2.	3.
Moisture at 100° C.,	76.21	86.32	72.90
Dry matter,	23.79	13.68	27.10
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	7.25	6.90	11.05
" cellulose,	31.73	26.66	24.73
" fat,	3.37	2.29	7.22
" protein,	7.70	16.01	13.64
Nitrogen-free extract matter,	49.95	48.14	43.36
	100.00	100.00	100.00

1893. — The system of manuring the same as in the preceding year; the general preparation of the soil and of the same crops in all plats alike.

Name of Crop raised (1893).	Entire Area occupied by the Crop.	Area occupied by Crop in Each Plat.
	Acres.	Acres.
Soja bean (broadcast),	1.68	.303
Vetch and oats (broadcast),	1.38	.248
Barley (broadcast),	1.94	.349

Amount of Seed used per Acre.

Soja beans (broadcast), 103 pounds.
Vetch, 50 pounds; oats, 4⅝ bushels.
Barley, 2¾ bushels.

Yield of Crops in Each Plat, calculated per Acre.

[Pounds.]

	Plat I.	Plat II.	Plat III.	Plat IV.	Plat V.
Soja bean (hayed in bloom),	3,564	3,498	825	2,442	4,092
Vetch and oats (hayed, cut in full bloom),	4,234	5,325	2,944	4,315	6,210
Barley, total (dry, matured),	3,837	2,579	2,178	2,894	2,149

A comparison of the yield of all the fertilized plats with that of the yield of the unfertilized plat shows the following difference in yield per acre, in pounds: —

	Plat I.	Plat II.	Plat IV.	Plat V.
1889.				
Barley in drills,	31	778	525	—570
Barley broadcast,	*	267	767	466
Dent corn (green),	3,354	3,785	5,274	4,183
1890.				
Vetch and oats (green),	4,734	1,076	3,164	3,221
Scotch tares (hay),	958	1,438	1,338	1,780
Soja bean (green),	1,724	2,243	3,310	2,992
1891.				
Barley, straw and chaff,	474	426	653	693
Barley, grain,	421	368	441	351
Oats in drills, straw and chaff,	631	922	1,242	812
Oats in drills, grain,	519	441	604	459
Oats broadcast, straw and chaff,	1,463	752	1,411	1,248
Oats broadcast, grain,	430	229	598	524
1892.				
Canada peas and oats (green),	–	2,570	3,810	3,533
Dent corn (green),	11,360	6,351	–	–
1893.				
Soja bean (hay),	2,731	2,673	1,617	3,267
Vetch and oats (hay),	1,290	2,379	1,371	3,266
Barley (matured, whole crop),	1,659	401	716	—29

* No difference.

Conclusions.

1. Soja beans should be planted in drills, to keep the weeds down. They grow too slowly to shade the ground sufficiently against objectionable vegetation.

2. Vetch and oats yield larger crops, suitable for green fodder, than soja bean, at an early part of the season. They yield also a larger crop of dry fodder for winter use.

3. Both crops, vetch and oats and soja bean, produce a valuable ensilage. Two weight parts of corn, cut when the kernels are glazing, and one weight part of early-maturing soja bean, have furnished us a valuable ensilage for winter and spring use.

1. Analysis of fodder corn for ensilage.
2. Analysis of corn and soja-bean ensilage.

	Per Cent.	
	1.	2.
Moisture at 100° C.,	68.53	77.42
Dry matter,	31.47	22.58
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	5.68	9.72
" cellulose,	22.99	25.01
" fat,	2.81	4.29
" protein,	6.22	6.82
Nitrogen-free extract matter,	62.30	54.16
	100.00	100.00

8. Experiments with Grass Land (Meadows).

The meadows under consideration comprise an area of about 9.6 acres. The entire field to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion and covered with weeds and sedges in its lower section. The improving of the land by underdraining and ploughing, and subsequently by the use of a system of drill culture, began in some parts (north end) in 1886 and in others (south end) in 1887. For details of this work, see ninth and tenth annual reports (1891–92).

1893. — In the spring of this year a change was made in the area and mode of manuring of the grass plats. The area was divided into three plats, Plat 1 (3.97 acres) being the area heretofore covered by plats 1 and 2; Plat 2 (2.59 acres) and Plat 3 (3 acres) correspond to plats 3 and 4 of former years.

The system of manuring adopted was as follows: —

Plat 1. — Wood ashes, 1 ton to the acre.
Plat 2. — Barn-yard manure, 8 tons to the acre.
Plat 3. — Six hundred pounds fine-ground bone and 200 pounds muriate of potash to the acre.

Yield of Hay (1893).

	Yield per Plat.			Rate per Acre.		
	Plat 1.	Plat 2.	Plat 3.	Plat 1.	Plat 2.	Plat 3.
First cut,	9.60	5.34	5.80	2.28	2.62	1.94
Second cut,	2.99	2.22	2.67	.77	.86	.64
Total yield,	12.59	7.56	8.47	3.05	3.48	2.58

Yield of Hay (1889–93).

	Rate per Acre (Tons).		
	First Cut.	Second Cut.	Total.
1889.			
Plat 1, barn-yard manure, 18 tons to acre,	2.73	1.14	3.87
Plat 2, barn-yard manure, 8 tons to acre,	2.38	1.21	3.59
Plat 3, 600 pounds of steamed bone and 200 pounds muriate of potash,	2.50	1.03	3.56
1890.			
Plat 1, barn-yard manure, 14 tons to acre,	3.80	1.00	4.80
Plat 2, barn-yard manure, 11 tons to acre,	3.25	1.34	4.59
Plat 3, as in 1889,	3.00	.73	3.73
Plat 4, wood ashes, 1 ton to acre,	2.23	.68	2.91
1891.			
Plat 1, barn-yard manure, 8 tons to acre,	3.26	.72	3.98
Plat 2, barn-yard manure, 6 tons to acre,	2.99	.72	3.71
Plat 3, as in 1890,	2.32	.51	2.83
Plat 4, as in 1890,	2.32	.51	2.83
1892.			
Plat 1, as in 1891,	2.77	1.04	3.81
Plat 2, as in 1891,	2.70	.98	3.68
Plat 3, as in 1891,	2.33	.64	2.97
Plat 4, as in 1891,	2.18	1.02	3.20
1893.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.28	.77	3.05
Plat 3, barn-yard manure, 8 tons to acre,	2.62	.86	3.48
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	1.94	.64	2.58

9. Report on General Farm Work (1893).

The lands assigned for the use of the Massachusetts State Agricultural Experiment Station cover an area of fifty acres. Ten acres are natural woodlands, and forty acres, including the space occupied by the buildings, are used for the raising of farm crops. At present from fifteen to sixteen acres are under cultivation, and from sixteen to seventeen acres are permanent grass lands. As every portion of the land is at present serving for some special experiment, the general management of the farm is to a controlling degree subjected to the requirements of the work called for in connection with the various questions under investigation. The adoption of a thorough mechanical preparation of the soil, supported by a careful, clean cultivation of the crops raised, has brought the lands into a fair condition for field experiments. Each field has had for years its own system of manuring, and becomes thereby from year to year more valuable for experimental purposes. Wherever circumstances have been favorable, forage crops have been chosen, for the purpose of studying the influence of various systems of fertilization and cultivation on their growth and special character. This practice has resulted already in the successful introduction of some valuable forage plants new to our locality, and has also materially assisted us in an economical support of quite extensive experiments in stock feeding. The beneficial effect of many of these crops on the physical and chemical condition of our cultivated lands is everywhere noticed, when compared with their previous general condition.

During the past season several varieties of soja bean, vetch and oats and buckwheat have been raised. The vetch and oats was fed in part green and in part as hay to dairy cows. The soja bean was fed as hay.

Twenty tons of corn have been put into the silos, and the remainder has been fed in part as fodder corn, or has been harvested when matured, and the corn stover obtained will serve for the support of dairy stock in place of hay.

The character and amount of farm and garden crops raised in 1893 may be seen from the following statement: —

	Tons.
Hay (first cut),	$31\frac{1}{3}$
Rowen,	$10\frac{1}{5}$
Potatoes,	$7\frac{1}{2}$
Oats (1,368 pounds grain, 5,032 pounds straw),	$3\frac{1}{5}$
Vetch and oats (hay),	$3\frac{2}{3}$
Vetch and oats (green),	$2\frac{1}{2}$
Fodder corn (green),	$26\frac{1}{2}$
Corn stover,	$5\frac{1}{2}$
Corn (ears),	$2\frac{3}{4}$
Soja bean (hay),	$2\frac{1}{6}$
Barley,	$2\frac{1}{3}$
Rye (226 pounds grain, 1,243 pounds straw),	$\frac{3}{4}$
Buckwheat (green),	$1\frac{1}{4}$
Tomatoes,	$2\frac{1}{4}$
Cabbages,	$1\frac{1}{3}$
Spinach,	$\frac{1}{2}$
Lettuce,	$\frac{1}{6}$
Roots (carrots, 5,540 pounds; beets, 2,194 pounds; turnips, 2,157 pounds),	5
Miscellaneous,	3
	$112\frac{9}{10}$

10. On Special Fertilization with Reference to Some Prominent Industrial Crops, Fruits and Garden Vegetables.

One of the first requirements for a healthful condition and subsequent successful propagation of any plant consists in adopting a well-devised system of fertilization.

A system of manuring may be called well devised or rational when it is based upon the results of a careful examination into the composition of the plant under cultivation, and on a due consideration of its natural qualifications for availing itself of the needed plant food both from the atmosphere and the soil in question. When raised under otherwise corresponding circumstances, plants with a well-developed and extensive root system may prosper where those with a compact one will fail; the same statement applies with equal force to the character of their leaf systems.

To ascertain with certainty the composition of a plant, especially with reference to its soil constituents, requires repeated examinations in different stages of its growth and when raised upon different kinds of soil. The relations of the various mineral constituents of the plant to its successful development must be fairly understood to know what elements of plant food ought to be present in the soil, in an available form, to render success possible.

Most of our farm plants have been carefully investigated, and their requirements regarding kind and amount of the various articles of plant food for their successful production may be considered fairly well understood. This circumstance cannot be claimed with the same certainty regarding the so-called "garden crops" and fruit-producing plants. Our stock of information with regard to these is in an exceptional degree unsatisfactory. The slowness of the exhaustive action of fruit trees on the soil, on account of their extensive root systems, and the beneficial effect of a frequent rotation of crops in case of garden plants, in connection with a customary liberal supply of vegetable refuse material and of home-made manures, have apparently delayed the need of a scientific inquiry into the special wants of the garden and

orchard on the part of agricultural chemists. A surplus in the quantity of manurial matter has no doubt quite frequently provided for special wants; and in this view is secured an intelligent explanation of the results. There is no scarcity of valuable testimony to the fact of exceptionally good success in raising fruits and garden crops by the aid of a liberal supply of compound manurial matters, such as barn-yard manure, vegetable compost of various descriptions, wood ashes and others of a similar varying and thus ill-defined composition; yet it is equally well understood that but little satisfactory explanation can be given in many instances regarding the particular relation which exists between the constituents or conditions of such manurial substances applied and the quantity and quality of the crops raised by their aid.

The world-wide reputation of barn-yard manure and wood ashes dates back not merely one or two centuries; their good effects have been known for thousands of years; and we have very good reason to believe that their general reputation rests on their complex character and their beneficial influence over various physical and chemical qualities of the soil. They contain in the majority of cases more or less of all the essential soil constituents which our cultivated farm and garden plants need, and they supply on that account, to some extent at least, not only known but also unknown deficiencies of plant food. They may thus ensure, other circumstances being favorable, for a longer or shorter period of time, reasonable success when applied in suitable quantities.

Experience has shown that refuse manurial matter, like barn-yard manure, is most efficient when used for the reproduction of those crops which contributed materially to its manufacture; a similar view may be maintained with reference to the manurial value of vegetable compost and ashes. The exceptional occurrence of these favorable conditions materially limits, in the light of our present information, their claim of being the best of manures for farm and garden under all circumstances, and needing no further supplementing to meet any special deficiencies of plant food. The whole aspect of the question how to manure efficiently has gradually but decidedly changed within the last fifty years.

We prefer to-day to speak of feeding plants. To secure the best possible results in feeding plants requires information with regard to the three following points: namely, with relation to the physical and chemical character of the soil in question; a knowledge of the special wants of the plant under cultivation, as regards the absolute and relative proportions of the various essential articles of plant food required; and a familiarity with the composition and the general physical properties of the different kinds of manurial matter at our disposal.

A brief statement of the principal results of a systematic, scientific examination into the circumstances which control a healthy and vigorous growth of plants may not be out of place here.

First. All our cultivated plants on the farm, in the garden and in the orchard contain the same elementary constituents, yet no two of them in the same absolute amounts and relative proportions. The list comprises carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, sodium, calcium, magnesium, silicon, chlorine (manganese?).

Second. These plant constituents are furnished in part by the surrounding atmosphere, in part by the soil, and some in varying proportions by both.

Third. The essential plant constituents are not needed in different plants in the same invariable proportions at the various successive stages of growth, but are wanted at different stages of growth in different absolute amounts and relative proportions. Each kind of plant has its especial wants at different stages of its development. (Grains require much nitrogen in an available form during their later period of growth, when blooming and forming seed, while grape vines need a large amount of potash during the growing and maturing of the fruit, etc)

Fourth. The absolute amount of the essential mineral constituents may vary in the same kind of plant when raised on different soils and in different climates without, as a rule, affecting the general character of the plant; yet it appears, however, that not one of the essential elements can to any extent replace another one without affecting more or less seriously the amount and relative proportion of the organic

constituents of the plant. It has been noticed that many of our cultivated plants are more or less susceptible of change in that direction, owing to a liberal application of one or the other essential constituent.

Fifth. It has also been shown that the particular form of the various articles of plant food, as well as the special associations in which they may be applied, exerts quite frequently a decided influence, not only on the quantity of the crop, but also on its quality.

The observations referred to above (*fourth* and *fifth*) deserve particularly the serious attention of all parties engaged in the raising of industrial crops, as well as garden crops and fruits; in fact, wherever a special quality of the product affects the commercial value of the same. We know that whenever such changes are made they are as apt to be in our favor as against our best interests. The history of the successful production of many of our industrial crops furnishes us with an abundance of illustrations of the existence of such relationships, as in the case of sugar-producing plants, tobacco, etc.

Sixth. The natural resources of the soil in available plant food have proved, as a rule, ultimately insufficient for a remunerative management of the farm, the garden and the orchard. Older systems of agriculture have failed on account of a scanty supply of plant food, and many failures in our present system of management will most likely be ascribed at some future day to an indifferent application of the essentials of plant food.

From the foregoing record of well-established conclusions, derived from actual observation in the vegetation house, the field and the garden, we can draw, if we desire, some valuable lessons for our guidance in the practical management of the various branches of agricultural and horticultural industry.

A careful consideration of the points stated cannot fail to impress all interested parties with the fact that to manure our lands efficiently means to-day something more than to incorporate into the soil an exceptionally liberal amount of some incidental refuse matter of ill-defined composition, as barn-yard manure, vegetable compost or wood ashes. Both good economy and the desirability of securing a successful

and thus economical production of the various farm and garden crops strongly advise the change from an indifferent system of manuring to a more rational one in every branch of agriculture and horticulture.

The steadily increasing consumption of agricultural chemicals and of commercial manurial compounds, for the purpose of supplementing our home resources of manurial matter, is a gratifying endorsement of the good service which systematic, scientific, experimental investigation into the causes of a successful production of remunerative crops have rendered to practical agriculture and horticulture.

Much has thus far been accomplished, considering the short period of time since our views regarding these points have changed; yet much more work is still necessary to secure a reasonably adequate control of the subject under discussion. To promote these interests it seems to be desirable that agricultural chemists render themselves more familiar with the best current modes of a successful horticultural practice, and that horticulturists make themselves familiar with the more recent results of the scientific investigations made in their interests by giving them a fair and careful trial in the practical pursuit of their business.

Every attempt at a rational and remunerative system of cultivation should begin with an inquiry into the location of the lands and the general condition of soil and climate, to ascertain the special fitness of each for the contemplated industry; and, in case the lands have already been under cultivation for years, their past history with regard to the system of cultivation carried on, as well as the character of the crops raised, ought to be consulted before any particular course of operation is decided upon. Inquiries in these directions cannot fail to give us some valuable insight into the character and extent of existing and available circumstances regarding plant food and the possibilities of success.

A due consideration of the character and amount of the existing available plant food of the soil, and some definite information in regard to the composition of the plant we propose to cultivate, ought to guide us in the selection of the kind and the quantity of the manurial substance. As plants require at different stages of growth different quanti-

ties of the essential articles of plant food, it must be the aim to provide a liberal amount of those essential constituents to meet these periodical wants. The well-known fact that liberal manuring pays better than a scanty one finds its explanation in the existence of the above conditions. The heavier the crop the larger should be the return of the constituents carried off from the soil, for that essential article of plant food which is present in the soil in less quantity than the growth of the plant requires controls the final result.

It has been the aim of the writer, since the establishment of the agricultural institutions at Amherst, to furnish object lessons to our farming community in regard to a rational system of fertilization by carrying on a series of field experiments with a variety of farm crops.

The local conditions of the soil with reference to the existing amount of plant food had to be, as far as practicable, determined by actual field trials before the special lines of investigation could be entered upon. Our earlier reports furnish abundant proof of the importance ascribed to a suitable preparation of each experimental plot for the special line of inquiry decided upon.

The natural inherent resources of the soil were usually ascertained by raising for several years in succession, without any manurial addition from outside sources, crops requiring different proportions of the essential articles of plant food, thereby reducing the soil to its normal condition regarding the amount of plant food present, as far as practicable.

Most prominent among the experiments carried on are those with relation to the effect of a liberal supply of the different forms of potash on sugar beets,* sorghum,† grapes,‡ potatoes § and several leguminous and grain crops ;||

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* See eighth, ninth and eleventh annual reports of the Massachusetts Agricultural College for the years 1871, 1872 and 1874.

† See sixteenth annual report of the Massachusetts Agricultural College for the year 1879.

‡ See thirteenth annual report of the Massachusetts Agricultural College for the year 1876.

§ For details see annual reports of the Board of Control of the Massachusetts State Agricultural Experiment Station for the years 1884-93.

|| For details see annual reports of the Board of Control of the Massachusetts State Agricultural Experiment Station for the years 1884-89.

those with relation to the effect of the different forms of nitrogen (ammonia salts, nitrates and organic nitrogen) on the yield and character of grain crops and leguminous plants; * those to determine the economy of using natural and commercial phosphates in the production of corn and grain crops; † experiments with permanent grass lands (meadows).

Of late our attention has been turned to a special study of the effect of different forms of nitrogen and potassium oxide on the growth of a series of prominent fruit and garden crops, and the results of two years' observations regarding the latter are already reported in detail upon preceding pages (Field C).

To explain the striking differences noticed in the yields of some of those crops, in particular lettuce and tomatoes, when raised with the assistance of either muriate or sulphate of potash, it seemed advisable for confirmation of the results to transfer the investigations to the vegetation house, where, under better-defined circumstances, the special effect of the kind and form of the various articles of plant food supplied could be more clearly demonstrated. A few notes regarding the results thus far obtained are subsequently stated, to invite co-operation on the part of persons interested in the questions involved.

Observations in the plant house with lettuce and spinach, during the winter of 1892–93, were conducted as follows: —

The soil used in the vegetation house was a sandy loam taken a few feet below the surface from a locality which at no time had received an additional supply of manurial matter from an outside source. It was sent through a screen before being used, to remove coarse vegetable matter (roots, etc.) as far as practicable. The beds of the vegetation house were divided into boxes thirty-two inches square and eight inches deep. They were filled with the earth to the depth of six inches, about three hundred pounds being used for the purpose.

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* For details see annual reports of the Board of Control of the Massachusetts State Agricultural Experiment Station for the years 1889–93.

† For details see annual reports of the Board of Control of the Massachusetts State Agricultural Experiment Station for the years 1890–93.

Each box received a fertilizer mixture of its own, nothing but commercial fertilizers and chemicals which had been carefully analyzed being used in their compounding. The amount of potassium oxide, phosphoric acid and nitrogen was the same in each case, the phosphoric acid in all cases being supplied by dissolved bone-black, while the potassium oxide in some cases was in the form of muriate of potash (I., II. and III.), in others of high-grade sulphate (IV., V. and VI.), and in the remainder (VII., VIII. and IX.) by potash-magnesia sulphate. The nitrogen was supplied in the form of sulphate of ammonia (II., IV. and VII), nitrate of soda (I., V. and VIII.) and dried blood (III., VI. and IX). These fertilizer mixtures were thoroughly incorporated with the soil. Each box was planted in part with lettuce and in part with New Zealand spinach. The same lot of seed sufficed for the whole, and the seeding took place on the same day. Throughout the growing period the boxes were treated similarly, as far as temperature and time and amount of watering were concerned.

The relative proportion of fertilizer applied was: of potassium oxide, 3 parts; of phosphoric acid, 1 part; and of nitrogen, 1 part. The percentage of the different ingredients added to the soil was as follows: —

	Per Cent.
Potassium oxide,	.00026
Phosphoric acid,	.00009
Nitrogen,	.00009

Fertilizer Mixtures used.

Box I.

90 grams muriate of potash.
100 grams dissolved bone-black.
100 grams nitrate of soda.

Box II.

90 grams muriate of potash.
100 grams dissolved bone-black.
100 grams sulphate of ammonia.

Box III.

90 grams muriate of potash.
100 grams dissolved bone-black.
140 grams dried blood.

Box IV.

90 grams sulphate of potash.
100 grams dissolved bone-black.
75 grams sulphate of ammonia.

Box V.

90 grams sulphate of potash.
100 grams dissolved bone-black.
100 grams nitrate of soda.

Box VI.

90 grams sulphate of potash.
100 grams dissolved bone-black.
140 grams dried blood.

Fertilizer Mixtures used — Concluded.

Box VII.

160 grams potash-magnesia sulphate.
100 grams dissolved bone-black.
75 grams sulphate of ammonia.

Box VIII.

160 grams potash-magnesia sulphate.
100 grams dissolved bone-black.
100 grams nitrate of soda.

Box IX.

160 grams potash-magnesia sulphate.
100 grams dissolved bone-black.
140 grams dried blood.

The lettuce seeded in the boxes containing muriate of potash as the potash source proved a complete failure, as the young plants attained a height of only one and one-half inches, the color of the leaves changed into various shades of red, and growth ceased. In the other boxes the results were less striking, but the most satisfactory growth was obtained in those boxes in which sulphate of potash or sulphate of potash-magnesia furnished the source of potash.

Less marked was the difference in growth of the New Zealand spinach, the plants growing in the boxes containing muriate of potash being less vigorous, yet the difference at the close of the experiment was less marked, except in regard to the time required to reach perfection. The most striking thing noticed with regard to these preliminary experiments was in relation to the apparently injurious effect of muriate of potash on lettuce. This result induced us to repeat the experiment in the vegetation house during the winter of 1893–94, for the exact quantities required to give the most beneficial results can obviously only be ascertained by a series of observations.*

* The soil in boxes 1, 2 and 3 was analyzed at the close of the observation, with the following result: —

	No. 1.	No. 2.	No. 3.
	Per Cent.	Per Cent.	Per Cent.
Potassium oxide,	.142	.136	.143
Phosphoric acid,	.119	.137	.163

Observations during the Winter of 1893–94.

The soil turned to account in these experiments was obtained two feet below the surface of an abandoned pasture, which had not received any addition of manurial matter from an outside source for many years.* The soil was screened, thus being freed from coarse material of every description. It consisted of a light loam. Twelve boxes, corresponding in size to those of the previous year (32 by 32 by 8 inches), were employed, each containing about three hundred pounds of the soil, being filled to within one inch of the top. To secure a thorough mixing of the fertilizer and soil, they were worked together with the shovel and the mixture sent twice through the screen. The addition of the fertilizer to the soil was made two weeks in advance of the seeding. A greater variety of fertilizer mixtures was turned to account, including those of the preceding year. The potassium oxide was furnished by muriate of potash (1, 2 and 3), sulphate of potash (4, 5, 6 and 12), carbonate of potash-magnesia (7, 8, 9 and 10) and phosphate of potash (11). The phosphoric acid was supplied by dissolved boneblack (1, 2, 3, 4, 5, 7, 8 and 9), odorless phosphate (6), double superphosphate (10), phosphate of potash (11) and phosphate of ammonia (12). The nitrogen was added in the form of nitrate of soda (1, 4, 7, 10 and 11), sulphate of ammonia (2, 5 and 8), phosphate of ammonia (12) and organic nitrogen (dried blood) (3, 6 and 9). The relative ratio of essential fertilizing constituents applied was four parts potassium oxide, one part phosphoric acid and one part nitrogen. The percentage of the essential elements of plant food applied to the soil was as follows: —

	Per Cent.
Potassium oxide,	.0004
Phosphoric acid,	.0001
Nitrogen,	.0001

Following is a statement of the fertilizer mixtures used: —

* Analysis of this soil showed: moisture, 14.25 per cent.; potassium oxide, .084 per cent.; and phosphoric acid, .134 per cent.

Box 1.

128 grams muriate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 2.

128 grams muriate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 3.

128 grams muriate of potash.
100 grams dissolved bone-black.
155 grams dried blood.

Box 4.

128 grams sulphate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 5.

128 grams sulphate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 6.

128 grams sulphate of potash.
90 grams odorless phosphate.
155 grams dried blood.

Box 7.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 8.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 9.

360 grams carbonate of potash-magnesia.
100 grams dissolved bone-black.
155 grams dried blood.

Box 10.

136 grams double superphosphate.
360 grams carbonate of potash-magnesia.
106 grams nitrate of soda.

Box 11.

200 grams phosphate of potash.
212 grams nitrate of soda.

Box 12.

145 grams phosphate of ammonia.
128 grams sulphate of potash.

Analyses of chemicals used in compounding the above mixtures will be found below: —

	Potassium Oxide.	Phosphoric Acid.	Nitrogen.
	Per Cent.	Per Cent.	Per Cent.
Muriate of potash,	46.00	–	–
Sulphate of potash,	50.20	–	–
Potash-magnesia sulphate,	24.32	–	–
Carbonate of potash-magnesia,	18.48	–	–
Phosphate of potash,	32.56	35.70	–
Dissolved bone-black,	–	13.88	–
Odorless phosphate,	–	18.42	–
Double superphosphate,	–	47.80	–
Phosphate of ammonia,	–	43.86	10.37
Dried blood,	–	4.02	10.00
Nitrate of soda,	–	–	14.28
Sulphate of ammonia,	–	–	19.59

A greater variety of garden vegetables was selected for trial. Each box was planted on October 11 with seed of the following : —

Lettuce, variety Hanson.
Spinach, variety New Zealand.
Beets, variety Egyptian.
Tomato, variety Essex Hybrid.

The boxes were treated similarly with regard to temperature and time of watering. To control the experiment, part of the vegetation house was turned to account to raise the same varieties of vegetables in the same soil, properly manured with vegetable compost from a successfully managed hot-bed. On October 17 the lettuce and spinach appeared, and by October 20 the remaining seeds had sprouted. The following notes relating to the different garden vegetables on trial may not be without interest in this connection, although still of a preliminary character : —

Lettuce. — The seed germinated well in all cases except with box 12, in which the number was somewhat scanty. During the first two or three weeks of growth the difference in the boxes was not very marked, although on November 20 1, 2 and 3 were noted as being generally of poorer quality than the others, with 4, 5 and 6 next. Nos. 2 and 5 were the poorest in their respective groups, as were the other boxes (8 and 12) in which the nitrogen was furnished by ammonia salts. On December 26 the lettuce was taken from 1, 2, 3, 4, 5 and 6, to make room for other plants; 1, 2 and 3 showed perhaps a less satisfactory growth than the others. January 10 the lettuce was removed from 9 and 10, having made a very satisfactory growth, and on January 10 from 7 and 8, also with a good growth.

Beets. — The seed germinated well in all cases, and during the first part of the growing period no very great differences were observed in the general appearance of the various boxes. The following table gives the heights of the plants at different dates : —

Height of Beets.

[Inches.]

DATE.	BOXES.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
December 5, . . .	2½	2¾	4	6½	3	4¾	8	7½	5½	8½	3½	3½
December 19, . . .	4	2¾	5	8½	3	6	10	9	7	9½	8½	3½

The plants were taken out of boxes 1, 2, 3, 5 and 6 on December 26, having apparently ceased their growth. They remained longer in box 4, which is provided with an arrangement for sub-irrigation, where they made a slightly larger growth. January 31 the plants were removed from boxes 7, 8, 9, 10 and 11, proving to be the best in 7 and 10.

Spinach. — This crop grew better in proportion in all the boxes than either of the others. In 1, 2 and 3 it made a fair growth, although not as vigorous as in the remaining boxes; 4, 5 and 6 showed a more vigorous and rapid growth, while 7, 8 and 9 proved to be still more vigorous. Boxes 10 and 11 showed a corresponding relative increase in growth, the plants being removed on January 3, when in bloom.

Tomatoes. — The growth of the tomatoes in 1, 2 and 3 was less satisfactory than in most of the others. An opinion regarding the degree of growth under the influence of the different fertilizers may be noticed from the following table, expressing the height of the plants at different periods of the observation: —

Height of Tomato Plants.

[Inches.]

DATE.	BOXES.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
December 5, . . .	5½	2¾	3	8	5	5	6½	8½	8	13½	9	8½
December 19, . . .	9½	6½	7	18	10	11½	11	14	14	24	21	21
January 9, . . .	26	10	25	36	22	22	28	31	32	45	44	43

The plants came in bloom as follows: in box 10, on December 18; in box 11, on December 20; in box 12, on December 23; in boxes 4, 5, 6, 7, 8 and 9 on January 1; and in boxes 1 and 3 on January 3. The plants in box 2 came in bloom February 15.

Fruit was formed first on the plants in box 10, noticed on January 17. It first appeared in box 12 on January 18; in boxes 4 and 9 on January 21; in box 3 on January 24; in box 1 on January 27; in box 8 on February 5; and in box 7 on February 28.

Fruit ripened in box 10 on February 20; in boxes 3, 4 and 12 on February 28; in box 9 on March 1; and in box 8 on March 7.

The plants grown in the soil manured with vegetable compost, as a sort of control experiment, made a very vigorous and healthy growth, but blossomed late and had formed no fruit up to March 8, although retaining their promising appearance.

Besides the above, the investigations during the close of the present winter season have been extended to the following garden vegetables, namely: peas, beans, onions, cauliflower, radish and turnip.

Some General Considerations for Garden Farmers.

1. Garden crops have usually a short period of growth, and for this reason need a soil rich in available plant food of various kinds, to meet periodical wants.

2. An excessive accumulation of half-decayed vegetable matter, as stable manure and compost prepared from the healthy refuse material of the garden, should be guarded against, in order to prevent, as far as practicable, the development of objectionable parasitic growths. Both sources of manurial matter are very valuable in their way, if used in limited quantities and properly supplemented by chemical manures and commercial fertilizers, to meet the special wants of the crops under cultivation.

3. A liberal use of commercial fertilizers and chemical manures for the production of garden vegetables and fruits deserves commendation, for they enable us to meet more directly the special wants of any soil for the production of crops raised in succession during the same season on the same lands. An excessive accumulation of soluble salines has, however, to be avoided, for some garden vegetables, as lettuce, etc., are very sensitive to their influence (see our observation).

4. It is advisable wherever practicable to change the position of different garden crops from season to season, to regulate the accumulation of the various essential constitu-

ents of plant food by raising vegetables consuming them in different proportions.

5. Wherever the quality of a crop controls its economical and commercial value, it seems advisable that care should be taken to secure the exclusion of an accumulation of soluble saline substances not called for by the crop. This circumstance deserves particular attention in cultivation under glass, where the body of soil is limited, and the removal of such substances by percolation to the lower layers offers but little chance of relief. In our experiment above described this view of the question of supplying plant food in the greenhouse has guided us in selecting a series of concentrated chemical manures, which for the above reason are now recommended for patronage.

6. There are, for obvious reasons, no unfailing receipts for a general fertilizer mixture best adapted to all kinds of soil for the production of field and garden crops, yet there are certain relative proportions of the essential articles of plant food which seem to recommend themselves for the raising of vegetables for the market. A mixture containing the proportion of twenty-four per cent. potassium oxide, twelve per cent. phosphoric acid and twelve per cent. nitrogen deserves a careful trial. In some cases it has been found advisable to add nitrogen at different times in small quantities in the form of nitrate of soda. This should be added at different stages of growth, and has been found desirable in the case of cabbages, turnips, cucumbers, onions, lettuce, asparagus, strawberries, grapes, fruit trees, etc. Peas, beans and all leguminous crops need no such addition, for after reaching a certain size they are qualified, by bacterial action upon their roots, to benefit by the elementary nitrogen of the atmosphere in sufficient amounts to secure success.

7. A regular periodical addition of a moderate amount of organic animal and vegetable refuse matter, as barn-yard manure and vegetable compost, may form an efficient part of the system of manuring adopted.

8. It has been found advantageous, in starting the cultivation of garden vegetables and orchards upon new lands, to enrich the lower layers of the soil by deep ploughing, together with the addition of a liberal supply of natural and commercial phosphates (South Carolina, Florida or odorless

phosphates, etc.), a treatment which may be repeated from time to time whenever practicable.

9. A periodical application of burnt lime or carbonate of lime has been found as a rule advantageous to lands used for the cultivation of garden vegetables wherever an excessive accumulation of organic vegetable matter is apt to occur (from one thousand to fifteen hundred pounds per acre may be used). The presence of a liberal amount of calcium carbonate in our cultivated lands is known to assist in many instances in the liberation of plant food from the soil and refuse vegetable material, and also to favor a beneficial bacterial life in the soil under cultivation.

The subsequent tabular statement of the composition of various garden crops, taken from the tables of E. Wolff and from observations made at Amherst, may not be without interest in this connection: —

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits and Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Chenopodiaceæ: —			
Mangolds,	1	6	2.3
*Mangolds,	1	4.2	2.1
Mangold leaves,	1	4.5	3
Sugar beets,	1	4.2	1.8
*Sugar beets,	1	4.8	2.2
Sugar beet tops,	1	2.3	1.7
Sugar beet leaves,	1	5.7	4.3
Sugar beet seed,	1	1.5	–
*Red beets,	1	4.1	3.3
Spinach,	1	1.7	3.1
*Spinach,	1	19.2	6.8
Compositæ: —			
Lettuce,	1	5.3	–
*Lettuce,	1	7.6	4
Head lettuce,	1	3.9	2.2
Roman lettuce,	1	2.3	1.8
*Jerusalem artichoke,	1	2.8	2.7
Convolvulaceæ: —			
Sweet potato,	1	4.6	3

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits and Garden Crops — Continued.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Cruciferæ: —			
White turnips,	1	3.6	2.3
*White turnips,	1	3.9	1.8
White turnip leaves,	1	3.1	3.3
*Ruta-bagas,	1	4.1	1.6
Savoy cabbage,	1	1.9	2.5
White cabbage,	1	4.1	1.7
*White cabbage,	1	11.0	7.6
Cauliflower,	1	2.3	2.5
Horse-radish,	1	3.9	2.2
Radishes,	1	3.2	3.8
Kohlrabi,	1	1.6	1.8
Cucurbitaceæ: —			
Cucumbers,	1	2	1.3
Pumpkins,	1	.6	.7
Ericaceæ: —			
*Cranberries,	1	3	–
*Cranberries,	1	3.4	2.6
Gramineæ: —			
Corn, whole plant, green,	1	3.7	1.9
*Corn, whole plant, green,	1	2.2	2.8
Corn kernels,	1	.6	2.8
*Corn kernels,	1	.6	2.6
*Corn, whole ears,	1	.8	2.5
*Corn stover,	1	4.4	3.7
Leguminosæ: —			
Hay of peas, cut green,	1	3.4	3.4
*Cow-pea (Dolichos),	1	3.1	2.9
*Small pea (Lathyrus),	1	3.4	4.2
Peas (seed),	1	1.2	4.3
Pea straw,	1	2.8	4
Garden beans (seed),	1	1.2	4
Bean straw,	1	3.3	–
Liliaceæ: —			
Asparagus,	1	1.3	3.6
Onions,	1	1.9	2.1
*Onions,	1	2.6	–

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits and Garden Crops — Concluded.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Rosaceæ: —			
Apples,	1	2.7	2
*Apples,	1	1.9	1.3
*Peaches,	1	1.3	–
Pears,	1	3.6	1.2
Strawberries,	1	1.4	–
*Strawberries,	1	2.6	–
*Strawberry vines,	1	.7	–
Cherries,	1	3.3	–
Plums,	1	4.3	–
Saxifragaceæ: —			
*Currants, white,	1	2.8	–
*Currants, red,	1	2.1	–
Gooseberries,	1	1.9	–
Solanaceæ: —			
Potatoes,	1	3.6	2.1
*Potatoes,	1	4.1	3
Potato tops, nearly ripe,	1	2.7	3.1
Potato tops, unripe,	1	3.7	5.3
*Tomatoes,	1	8.7	4.5
Tobacco leaves,	1	6.2	5.3
Tobacco stalks,	1	3.1	2.7
Tobacco stems,	1	10.7	3.8
Umbelliferæ: —			
Carrots,	1	2.7	2
*Carrots,	1	5.7	1.7
Carrot tops,	1	2.9	5.1
*Carrot tops, dry,	1	8	5.1
Parsnips,	1	3.8	2.8
*Parsnips,	1	3.3	1.2
Celery,	1	3.5	1.1
Vitaceæ: —			
Grapes,	1	3.6	1.2
Grape seed,	1	1	2.7

Fertilizing Constituents of Fruits and Garden Crops.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ: —										
Mangolds,	880	1.8	9.1	4.8	1.5	.3	.4	.8	.3	.9
*Mangolds,	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–
Mangold leaves,	905	3.0	14.6	4.5	2.8	1.6	1.4	1.0	.8	2.3
Sugar beets,	805	1.6	7.1	3.8	6	.4	.6	.9	.3	.3
*Sugar beets,	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Sugar beet tops,	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Sugar beet leaves,	897	3.0	15.3	4.0	2.0	3.1	1.7	.7	.8	1.3
Sugar beet seed,	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
*Red beets,	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–
Spinach,	903	2.4	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
*Spinach,	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositeæ: —										
Lettuce, common,	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Head lettuce,	943	2.2	10.3	3.9	.8	1.5	.6	1.0	.4	.8
*Head lettuce,	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Roman lettuce,	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4
Artichoke,	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
*Artichoke, Jerusalem,	775	4.6	–	4.8	–	–	–	1.7	–	–
Convolvulaceæ: —										
Sweet potato,	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ: —										
White turnips,	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
*White turnips,	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
White turnip leaves,	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2
*Ruta-bagas,	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Savoy cabbage,	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
White cabbage,	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
*White cabbage,	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cabbage leaves,	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cauliflower,	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish,	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	4.5	.3	.5
Kohlrabi,	850	4.8	12.3	4.3	.8	.4	.8	2.7	1.1	.6

Fertilizing Constituents of Fruits and Garden Crops — Continued.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Cucurbitaceæ: —										
Cucumbers, ...	956	1.6	5.8	2.4	.6	.4	.2	1.2	.4	.4
Pumpkins, ...	900	1.1	4.4	.9	.9	.3	.2	.7	.3	.4
Ericaceæ: —										
*Cranberries, ...	996	–	1.8	.9	.1	.3	.1	.3	–	–
*Cranberries, ...	894	.8	–	1.0	–	.2	.1	.3	–	–
Gramineæ: —										
Corn, whole plant, green, .	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5
*Corn, whole plant, green, .	786	4.1	–	3.8	.5	1.5	.9	1.5	–	–
Corn kernels, ...	144	16.0	12.4	3.7	.1	.3	1.9	5.7	.1	.2
*Corn kernels, ...	100	18.2	–	4.0	.3	.3	2.1	7.0	–	–
*Corn, whole ears, . . .	90	14.1	–	4.7	.6	.2	1.8	5.7	–	–
*Corn stover, ...	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	–	–
Leguminosæ: —										
Hay of peas, cut green, .	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
*Cow-pea (Dolichos), green, .	788	2.9	–	3.1	.6	3.0	1.0	1.0	–	–
*Small pea (Lathyrus), dry, .	90	38.5	–	25.7	4.7	17.9	5.0	9.0	–	–
Peas (seed), ...	143	35.8	23.4	10.1	.2	1.1	1.9	8.4	.8	.4
Pea straw, ...	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Garden beans (seed), . .	150	39.0	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Bean straw, ...	166	–	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
Liliaceæ: —										
Asparagus, ...	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3
Onions, ...	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
*Onions, ...	892	–	4.9	1.8	.1	.4	.2	.7	–	–
Rosaceæ: —										
Apples, ...	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
*Apples, ...	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
*Peaches, ...	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears, ...	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–
Strawberries, ...	902	–	3.3	.7	.9	.5	–	.5	.1	.1
*Strawberries, ...	–	–	5.2	2.6	.2	.7	.4	1.0	–	–
*Strawberry vines, . . .	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Cherries, ...	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
Plums, ...	838	–	2.9	1.7	–	.3	.2	.4	.1	–

Fertilizing Constituents of Fruits and Garden Crops — Concluded.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Saxifragaceæ: —										
*Currants, white,	–	–	5.9	3.1	.2	1.	.3	1.1	–	–
*Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	–	–
Solanaceæ: —										
Potatoes,	750	3.4	9.5	5.8	.3	.3	.5	1.6	.6	.3
*Potatoes,	798	2.1	9.9	2.9	.1	.1	.2	.7	–	–
Potato tops, nearly ripe,	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe,	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
*Tomatoes,	940	1.7	–	3.6	–	.3	.2	.4	–	–
Tobacco leaves,	180	34.8	140.7	40.7	4.5	50.7	10.4	6.6	8.5	9.4
Tobacco stalks,	180	24.6	64.7	28.2	6.6	12.4	.5	9.2	2.2	2.4
*Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	–	–
Umbelliferæ: —										
Carrots,	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.5	.4
*Carrots,	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops,	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry,	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Parsnips,	793	5.4	10.0	5.4	.2	1.1	.6	1.9	.5	.4
*Parsnips,	803	2.2	–	6.2	.1	.9	.5	1.9	–	–
Celery,	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8
Vitaceæ: —										
Grapes,	830	1.7	8.8	5.0	.1	1.0	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

Most of the foregoing analyses were compiled from the tables of E. Wolff. Those marked * are from analyses made at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

C. A. Goessmann.

I.

COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1893, to May 1, 1894.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.
7. Miscellaneous fodder analyses.

1. General Introduction.

Fifty-two manufacturers and dealers have applied for and received licenses for the sale of their various brands in our State. Twenty-four of them are residents of other States.

Two hundred and thirty-five samples of licensed articles have been collected in all parts of the State by authorized agents of the station. Two hundred and fourteen of them have been carefully analyzed at the chemical laboratory of the station, with the following results: one sample contained all three essential constituents above the highest guarantee; seventeen samples contained two of the essential elements above the highest guarantee; forty-five contained one essential element above the highest guarantee; sixty-eight contained three essential elements at the lowest guarantee; fifty-seven contained two essential elements at the lowest guarantee; thirty-one contained one element at lowest guarantee; one sample contained three essential elements below the lowest stated guarantee; fourteen samples contained two essential elements below the lowest stated guarantee; fifty-one contained one element below the lowest stated guarantee.

The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others.

The variations in the market price of prominent fertilizer constituents have been, on the whole, during the past year within the usual limits. Phosphoric acid in all forms has been offered at a somewhat lower figure than last year, while nitrogen in its leading forms has been somewhat higher.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate*, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not infrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does not express *their respective agricultural value*, *i. e.*, their crop-producing value; for the higher or lower market price

of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information, namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, *i. e.*, phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (*i. e.*, the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together,

we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1893.

	Cents per Pound.
Nitrogen in ammonia salts,	17
Nitrogen in nitrates,	15½
Organic nitrogen in dry and fine-ground fish, meat, blood, and in high-grade mixed fertilizers,	17½
Organic nitrogen in cotton-seed meal, linseed meal and castor pomace,	16½
Organic nitrogen in fine-ground bone and tankage,	15
Organic nitrogen in fine-ground medium bone and tankage,	12

Trade Values of Fertilizing Ingredients, etc. — Concluded.

	Cents per Pound.
Organic nitrogen in medium bone and tankage,	9
Organic nitrogen in coarse bone and tankage,	7
Organic nitrogen in hair, horn shavings and coarse fish scraps,	7
Phosphoric acid soluble in water,	6½
Phosphoric acid soluble in ammonium citrate,	6
Phosphoric acid in fine bone and tankage,	6
Phosphoric acid in fine medium bone and tankage,	5
Phosphoric acid in medium bone and tankage,	4
Phosphoric acid in coarse bone and tankage,	3
Phosphoric acid in fine-ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes,	5
Phosphoric acid insoluble (in ammonium citrate) in mixed fertilizers,	2
Potash as high-grade sulphate, and in mixtures free from muriate,	5½
Potash as muriate,	4½

The manurial constituents contained in feed stuffs are valued as follows: —

	Cents per Pound.
Organic nitrogen,	17½
Phosphoric acid,	5
Potash,	5½

The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones or other equally good forms, and not from leather, shoddy, hair or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1893, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials*, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent.

in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as: —

Sulphate of ammonia,	Dry ground fish,
Nitrate of soda,	Azotin,
Muriate of potash,	Ammonite,
Sulphate of potash,	Castor pomace,
Dried blood,	Bone and tankage,
Dried ground meat,	Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. The Provisions of the Act are as follows:

[Chapter 296.]

An Act to regulate the sale of commercial fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Sect. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of

said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

SECT. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of

said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles, nitrogen, phosphoric acid and potassium oxide, guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they

desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates should be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances — as fodder articles, fertilizers, etc. — coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

3. LIST OF MANUFACTURERS AND DEALERS WHO HAVE SECURED CERTIFICATES FOR THE SALE OF COMMERCIAL FERTILIZERS IN THIS STATE DURING THE PAST YEAR (MAY 1, 1893, TO MAY 1, 1894) AND THE BRANDS LICENSED BY EACH.

Allison, Stroup & Co., New York, N. Y.: —
Odorless Phosphate.
Canada Wood Ashes.

Ames Fertilizer Company, Peabody, Mass.: —
Plymouth Rock Brand.
Special Potato Fertilizer.
Pure Fine Bone.

H. J. Baker & Bro., New York, N. Y.: —
"A A" Ammoniated Superphosphate.
Special Potato Manure.
Special Grass Manure.
Special Tobacco Manure.
Special Corn Manure.
Pure Ground Bone.

C. A. Bartlett, Worcester, Mass.: —
Ground Bone.
Animal Fertilizer.

Bowker Fertilizer Company, Boston, Mass.: —
Stockbridge Special Manures.
Bowker's Hill and Drill Phosphate.
Bowker's Farm and Garden Phosphate, or Ammoniated Bone.
Bowker's Lawn and Garden Dressing.
Bowker's Fish and Potash.
Bowker's Potato and Vegetable Manure.
Bowker's Sure Crop Bone Phosphate.
Gloucester Fish and Potash.
Bowker's Dried Ground Fish.
Bowker's Fresh Ground Bone.
Nitrate of Soda.
Dried Blood.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.

Bradley Fertilizer Company, Boston, Mass. : —
Bradley's XL Phosphate.
BD Sea Fowl Guano.
Bradley's Potato Manure.
Original Coe's Superphosphate.
Bradley's Complete Manures.
Breck's Fertilizer.
High-grade Tobacco Manure.
Bradley's English Lawn Fertilizer.
Farmer's New Method Fertilizer.
Bradley's Fish and Potash.
Bradley's Pure Fine-ground Bone.
Dissolved Bone-black.
Nitrate of Soda.
Sulphate of Ammonia.
Muriate of Potash.
Sulphate of Potash.

W. J. Brightman & Co., Tiverton, R. I. : —
Dry Ground Fish.
Fish and Potash.
Superphosphate.

Bryant & Brett, New Bedford, Mass. : —
Ground Bone.

Burgess & Roy, South Attleborough, Mass. : —
Animal Fertilizer.

Joseph Church & Co., Tiverton, R. I. : —
Special Fertilizer (B Brand).
Standard Fertilizer (C Brand).
Fish and Potash (D Brand).

Clark's Cove Fertilizer Company, Boston, Mass. : —
Bay State Fertilizer.
Bay State Fertilizer, G. G.
Great Planet "A" Manure.
King Philip Guano.
Potato and Tobacco Fertilizer.
Fish and Potash.

Clark's Cove Fertilizer Company, Boston, Mass. — *Concluded.*
Tobacco Fertilizer.
Ground Bone.
Potato Manure.
Muriate of Potash.
Nitrate of Soda.
Sulphate of Potash.

Cleveland Dryer Company, Boston, Mass. : —
Cleveland Superphosphate.
Cleveland Potato Phosphate.
Cleveland Corn and Grain Phosphate.
Cleveland Fertilizer.

Cleveland Linseed Oil Company, Cleveland, O. : —
Tobacco Fertilizer.

E. Frank Coe, New York, N. Y. : —
Alkaline Bone Phosphate.
Special Tobacco Fertilizer.
Potato Fertilizer.
Ammoniated Bone Superphosphate.
Fish Guano and Potash.
Gold Brand Excelsior Guano.
Red Brand Excelsior Guano.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. : —
Ammoniated Bone Superphosphate.
Potato, Tobacco and Hop Phosphate.
Special Potato Manure.
Ammoniated Wheat and Corn Phosphate.
New Rival Ammoniated Superphosphate.
Ammoniated Practical Superphosphate.
Vegetable Bone Superphosphate.
Lawn Fertilizer.
Pure Ground Bone.
Ground Bone Meal.

Cumberland Bone Company, Portland, Me. : —
Cumberland Superphosphate.
Cumberland Potato Fertilizer.
Cumberland Fertilizer.

L. B. Darling Fertilizer Company, Pawtucket, R. I. : —
Darling's Animal Fertilizer.
Darling's Extra Bone Phosphate.
Darling's Potato and Root Crop Fertilizer.
Darling's Lawn and Garden Fertilizer.
Darling's Tobacco Grower.
Darling's Pure Fine Bone.
Darling's Pure Dissolved Bone.

John C. Dow & Co., Boston, Mass. : —
Dow's Ground Bone Fertilizer.
Dow's Nitrogenous Superphosphate.
Dow's Ground Bone.

Forest City Wood Ash Company, Boston, Mass. : —
Canada Unleached Hardwood Ashes.

William E. Fyfe & Co., Clinton, Mass. : —
Star Brand Canada Wood Ashes.

Great Eastern Fertilizer Company, Rutland, Vt. : —
Great Eastern General, for Grass and Grain.
Great Eastern Vegetable, Vine and Tobacco Fertilizer.
Great Eastern General, Oats, Buckwheat and Seeding-down Phosphate.

James J. H. Gregory & Son, Marblehead, Mass. : —
Gregory's Combination Fertilizer.
Gregory's Corn Fertilizer.
Gregory's Potato Fertilizer.

Hargraves' Manufacturing Company, Fall River, Mass. : —
Ground Bone.

Edmund Hersey, Hingham, Mass. : —
Fine-ground Bone.

Thomas Hersom & Co., New Bedford, Mass. : —
Meat and Bone.
Bone Meal.

John G. Jefferds, Worcester, Mass. : —
Animal Fertilizer.
Potato Manure.
Ground Bone.

John Joynt, St. Helens, Ont. : —
Canada Hardwood Unleached Ashes.

F. R. Lalor, Dunnville, Ont. : —
Canada Hardwood Ashes (Maple Brand).

A. Lee & Co., Lawrence, Mass. : —
Lawrence Fertilizer.

Lowell Bone Fertilizer Company, Lowell, Mass. : —
Lowell Bone Fertilizer.

Mapes Formula and Peruvian Guano Company, NewYork, N.Y. : —
Mapes Superphosphates.
Mapes Special Crop Manures.
Peruvian Guanos.
Bone Manures.
Sulphate of Potash.

James E. McGovern, Lawrence, Mass. : —
Ground Bone.
West Andover Market Bone Phosphate.

Monroe, DeForest & Co., Oswego, N. Y. : —
Hardwood Ashes.

National Fertilizer Company, Bridgeport, Conn. : —
Chittenden's Complete Fertilizers.
Chittenden's Universal Phosphate.
Chittenden's Fish and Potash.
Chittenden's Ground Bone.

Pacific Guano Company, Boston, Mass. : —
Pacific Guano.
Potato Manure.
Potato and Tobacco Fertilizer.
Fish and Potash.
High-grade General Fertilizer.

John J. Peters, Long Island City, N. Y.: —
Sheep Fertilizer.

Prentiss, Brooks & Co., Holyoke, Mass.: —
Complete Manures.
Phosphate.
Tankage.
Dissolved Bone-black.
Nitrate of Soda.
Muriate of Potash.

Preston Fertilizer Company, Greenpoint, Long Island: —
Ammoniated Bone Superphosphate.

Quinnipiac Fertilizer Company, Boston, Mass.: —
Quinnipiac Phosphate.
Quinnipiac Potato Manure.
Quinnipiac Market Garden Manure.
Quinnipiac Corn Manure.
Quinnipiac Fish and Potash (Crossed Fishes).
Quinnipiac Fish and Potash (Plain).
Quinnipiac Havana Fertilizer.
Quinnipiac Onion Manure.
Quinnipiac Bone Meal.
Quinnipiac Grass Fertilizer.
Quinnipiac Dry Ground Fish.
Quinnipiac Potato and Tobacco Fertilizer.
Sulphate of Potash.
Muriate of Potash.
Nitrate of Soda.

The Read Fertilizer Company, Syracuse, N. Y.: —
Read's Standard Phosphate.
H. G. Farmer's Friend.
Fish and Potash.
Vegetable and Vine Phosphate.

John S. Reese & Co., Baltimore, Md.: —
New England Favorite.
Potato Special.
Pilgrim.
Mayflower.
Columbus A.

Lucien Sanderson, New Haven, Conn. : —
Formula A.
Formula B.
H. G. Sulphate of Potash.
Sulphate Potash-magnesia.
Dry Ground Fish.
Blood, Meat and Bone.
Dissolved Bone-black.
Nitrate of Soda.
Muriate of Potash.

Edward H. Smith, Northborough, Mass. : —
Ground Bone.

Springfield Provision Company, Brightwood, Mass. : —
Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass. : —
Superphosphate.
Standard Fertilizer.
Potato and Tobacco Fertilizer.
Complete Manure.
Standard Guano.

Chas. Stevens, Napanee, Ont. : —
"Beaver Brand" Canada Hardwood Ashes.

F. C. Sturtevant, Hartford, Conn. : —
Sturtevant's Tobacco and Sulphur.

J. A. Tucker & Co., Boston, Mass. : —
Original Bay State Bone Superphosphate.
Imperial Bone Superphosphate.

Walker, Stratman & Co., Pittsburg, Pa. : —
Potato Special.
Tobacco Special.
Banner Fertilizer.
Four-fold Fertilizer.

Whittemore Bros., Wayland, Mass. : —
Whittemore's Complete Manure.

Leander Wilcox, Mystic, Conn. : —

Potato, Onion and Tobacco Manure.
Ammoniated Bone Phosphate.
H. G. Fish and Potash.
Dry Ground Fish Guano.

Williams & Clark Fertilizer Company, Boston, Mass. : —

Ammoniated Bone Superphosphate.
Universal Ammoniated Dissolved Bone.
High-grade Special.
Lawn Dressing.
Potato and Tobacco Manure.
Fine Wrapper Tobacco Grower.
Royal Bone Phosphate.
Prolific Crop Producer.
Potato Phosphate.
Corn Phosphate.
Grass Manure.
Onion Manure.
Pure Bone Meal.
Dry Ground Fish.
Fish and Potash.
Dissolved Bone-black.
Nitrate of Soda.
Muriate of Potash.
Sulphate of Potash.

4. Analyses of Licensed Fertilizers collected during 1893 in the General Markets by the Agent of the Massachusetts State Agricultural Experiment Station.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
9	Potato Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
10	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
12	XL Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
13	Potato Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
14	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
19	Blood, Meat and Bone,	Springfield Provision Company, Brightwood, Mass.,	Brightwood.
40	XL Superphosphate of Lime,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
55	Castor Pomace,	H. J. Baker & Bro., New York, N. Y.,	Amherst.
64	Sheep Fertilizer,	John J. Peters, Long Island City, N. Y.,	Boston.
69	Canada Unleached Wood Ashes,	Forest City Wood Ash Company, London, Ont.,	Boston.
71	Complete Corn and Grain Manure,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
73	Pacific Guano,	Pacific Guano Company, Boston, Mass.,	Newburyport.
100	King Philip Guano,	Clark's Cove Fertilizer Company, Boston, Mass.,	Lawrence.
102	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Fitchburg.
106	Potato, Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lowell.

108	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Mansfield.
110	High-grade Potato Fertilizer,	E. Frank Coe, New York, N. Y.,	Palmer.
150	Potato, Hop and Tobacco Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
171	Pilgrim Fertilizer,	John S. Reese & Co., Baltimore, Md.,	Pittsfield.
225	Canada Unleached Wood Ashes,	Forest City Wood Ash Company, London, Ont.,	Amherst.
226	South Carolina Floats,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
227	Cotton-seed Meal,	(Agent) S. P. Puffer, North Amherst, Mass.,	North Amherst.
228	Linseed Meal,	Cleveland Linseed Oil Company, Cleveland, Ohio,	Amherst.
229	Odorless Phosphate,	Pottstown Iron Company, Pottstown, Penn.,	Amherst.
	Chemicals.		
50	High grade Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
52	Sulphate of Ammonia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
53	Dried Blood,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
57	Nitrate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
	Bones.		
49	Steamed Fine-ground Bone,	Edward H. Smith, Northborough, Mass.,	Amherst.
81	Pure Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
148	Ground Bone,	Edmund Hersey, Hingham, Mass.,	Amherst.
155	Pure Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
9, 13	Potato Phospate,	14.56	2.80	2.47—3.30	4.39	2.07	1.77	8.23	7—11	6.46	6—9	6.03	5—6
10	Dry Ground Fish,	10.62	8.86	7.41—9.06	1.11	3.68	2.05	6.84	7—9	4.79	-	-	-
12, 40	XL Superphosphate of Lime,	14.85	2.78	2.50—3.25	7.55	2.05	2.17	11.77	11—14	9.60	9—11	2.45	2—3
14, 102	Potato Manure,	14.70	2.33	2.47—3.30	4.30	1.84	1.74	7.88	7—11	6.14	6—9	5.22	5—6*
19	Blood, Meat and Bone,	11.68	8.04	7—8	.36	5.17	3.58	9.11	9.5—10.5	5.53	-	-	-
55	Castor Pomace,	10.08	5.60	5—6	-	-	-	2.26	-	-	-	3.40	-
64	Sheep Fertilizer,	29.07	2.01	1.65	-	-	-	1.22	1.20	-	-	2.38	1.70
69, 225	Canada Unleached Wood Ashes,	10.84	-	-	-	-	-	1.38	1.5—2.5	-	-	6.25	4.5—8
71	Complete Corn and Grain Manure,	10.60	3.02	3.30—4.12	2.94	10.31	2.61	15.86	13—15	13.25	12—14	5.50	3—4
73	Pacific Guano,	17.52	2.22	2.25—3	6.45	3.21	.70	10.36	10.50—16	9.66	8.5—12	2.00	2—3

100	King Philip Guano,	17.69	1.23	1.03—1.64	6.40	2.30	1.02	9.72	9—12	8.70	8—10	2.13	2—3		
106, 150	Potato, Hop and Tobacco Phosphate,	14.08	2.02	2.1—3.2	7.68	1.66	1.41	10.75	10—12	9.34	10—12	3.53	3.2—4.3*		
108	Vegetable, Vine and Tobacco Fertilizer,	14.74	2.28	2.06—2.88	7.16	1.12	.90	9.18	8—12	8.28	8—12	5.74	6—8		
110	High-grade Potato Fertilizer,	11.25	1.75	2—2.5	5.88	1.90	1.74	9.52	10—13	7.78	8—10	5.27	6—7*		
171	Pilgrim Fertilizer,	17.34	.89	1.23—2.70	3.45	4.10	1.02	8.57	7.5—10.5	7.55	6.5—8	3.36	3—4		
226	South Carolina Floats,	.83	-	-	-	2.33	21.06	23.39	-	2.33	-	-	-		
227	Cotton-seed Meal,	8.65	6.50	-	-	-	-	3.17	-	-	-	2.25	-		
228	Linseed Meal,	10.43	5.91	5.80—6.20	-	-	-	1.95	1.98—2.20	-	-	1.08	1.30—1.50		
229	Odorless Phosphate,	.63	-	-	-	-	-	18.42	18.00	-	-	-	-		
	Chemicals.														
50	High-grade Sulphate of Potash,	1.36	-	-	-	-	-	-	-	-	-	50.20	48—52		
52	Sulphate of Ammonia,	1.50	19.59	19.78—20.60	-	-	-	-	-	-	-	-	-		
53	Dried Blood,	7.69	10	9.06—10.71	-	-	-	4.02	-	-	-	-	-		
57	Nitrate of Potash,	1.80	12.79	12.57	-	-	-	-	-	-	-	45.04	41.88		
												Mechanical Analysis.			
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.
49	Steamed Fine-ground Bone,	4.85	4.02	4.02	.29	9.77	12.90	22.96	22.96	10.06	10.06	40.70	41.24	18.06	-
81, 155	Pure Ground Bone,	5.82	3.89	2.9—3.7	.13	10.61	15.36	26.10	25.00	10.74	-	36.32	30.00	25.50	8.18
148	Ground Bone,	3.34	3.13	3—4	.13	13.95	10.36	24.44	19.25	14.08	-	51.72	14.89	20.91	12.48

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
1	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
11	Hampden Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
17	Ammoniated Bone Superphosphate,	Williams & Clark, Boston, Mass.,	Springfield.
18	Fish and Potash (Crossed Fish Brand),	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
28	Complete Manure for Potatoes and Root Crops,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
32	Stockbridge Complete Manure for Potatoes and Vegetables,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
34	Fish and Potash (D Brand),	Joseph Church & Co., Tiverton, R. I.,	Springfield.
36	Complete Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
42	Animal Fertilizer,	J. G. Jefferds, Worcester, Mass.,	Worcester.
65	Complete Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
76	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
77	Bay State Fertilizer,	Clark's Cove Fertilizer Company, Boston, Mass.,	Lawrence.
80	Lawrence Fertilizer,	A. Lee & Co , Boston, Mass.,	Lawrence.
82	Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Lowell.
86	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
90	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Lowell.
98	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Fitchburg.

129	Ammoniated Bone Superphosphate,	Williams & Clark, Boston, Mass.,	Dighton.
141	Bay State Fertilizer,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
147	Fish and Potash (D Brand),	Joseph Church & Co., Tiverton, R. I.,	Taunton.
153	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
157	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
199	Special Potato Manure,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
201	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
	Bones.		
24	Fine-ground Bone,	Gilbert E. Holmes, Worcester, Mass.,	Worcester.
83	Ground Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
124	Ground Bone,	Hargraves Manufacturing Company, Fall River, Mass.,	Fall River.
127	Fine-ground Bone,	Bryant & Brett, New Bedford, Mass.,	New Bedford.
128	Pure Bone Meal,	Thomas Hersom & Co., New Bedford, Mass ,	New Bedford.
154	Ground Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
215	Fine-ground Bone,	Bryant & Brett, New Bedford, Mass.,	Amherst.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
1, 201	Potato Special,	11.70	1.72	2.47—3.30	5.12	2.54	5.90	13.56	12—13	7.66	10—11	7.01	5—6
11	Hampden Lawn Dressing,	8.16	4.86	3.30—4.12	1.41	3.58	1.92	6.91	7—9	4.99	6—8	3.13	2—3
17, 129	Ammoniated Bone Superphosphate,	12.98	2.47	2.47—3.30	7.55	2.94	1.28	11.77	10—13	10.49	9—11	2.11	2—3
18	Fish and Potash (Crossed Fish Brand),	21.05	4.90	3.30—4.12	2.35	2.55	2.26	7.16	5—8	4.90	3—5	5.60	3—5
28	Complete Manure for Potatoes and Root Crops,	9.75	3.30	4.12—4.94	3.97	2.05	3.04	9.06	6—8	6.02	5—6	8.76	8—10
32	Stockbridge Complete Manure for Potatoes and Vegetables,	10.34	3.31	3.25—4.25	4.95	3.15	4.08	12.18	8—10	8.10	7—8	6.97	5—6
34, 147	Fish and Potash (D Brand),	21.40	2.58	2.47—3.30	2.81	3.43	1.33	7.57	7.5—8.5	6.24	-	1.84	2—3
36	Complete Potato Manure,	8.69	3.70	3.30	3.45	2.10	1.84	7.39	-	5.55	5.75	9.25	10
42	Animal Fertilizer,	10.67	2.25	2.47—3.30	6.04	1.76	8.17	15.97	16—18	7.80	11—13	3.69	2.5—3.5
65	Complete Animal Fertilizer,	4.44	5.78	3.30—4.12	.95	6.57	5.17	12.69	16—18	7.52	-	7.12	7—8
76, 98	English Lawn Dressing,	8.20	4.78	4.95—5.78	1.28	3.66	2.30	7.24	6—8	4.94	5—7	2.86	2.5—3.5*

77, 141	Bay State Fertilizer,	14.80	2.42	2.47—3.30	6.72	4.16	1.94	12.82	10—14	10.88	9—12	2.28		2—3*	
80	Lawrence Fertilizer,	12.94	2.63	2.06—2.26	7.16	2.11	1.48	10.75	10—12	9.27	-	2.70		2—3	
82	Animal Fertilizer,	12.92	2.99	3—4.5	3.48	3.73	1.87	9.08	10—12	7.21	6—8	5.83		4—5	
86, 153, 199	Special Potato Manure,	15.12	3.37	3.71—4.57	6.60	1.92	.84	9.36	8—9	8.52	8—9.5	5.51		5.4—6.4*	
90, 157	Ammoniated Bone Superphosphate,	13.47	2.92	2.8—3.7	6.81	2.60	1.59	11.00	10—12	9.41	10—12	1.08		1—2*	
												Mechanical Analysis.			
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.
24	Fine-ground Bone,	9.15	2.90	2.50—3.50	.20	7.90	12.57	20.67	22—24	8.10	-	16.64	23.43	49.73	10.20
83, 154	Ground Bone Meal,	13.15	1.21	2—3	.32	10.49	17.00	27.81	25—28	10.81	-	17.57	47.70	25.47	9.26
124	Ground Bone,	13.80	3.52	2.5—2.8	.51	8.19	12.54	21.24	25—27	8.70	-	17.86	19.86	18.56	43.72
127, 215	Fine-ground Bone,	7.61	2.78	2.50	.26	8.44	16.50	25.20	25.56	8.70	-	38.43	32.95	19.17	9.45
128	Pure Bone Meal,	4.84	1.75	2.00	.38	10.11	19.57	30.06	29.21	10.49	9.40	74.15	19.04	6.81	-

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
91	Quinnipiac Phosphate,	Quinnipiac Fertilizer Company, Boston, Mass.,	Fitchburg.
96	Cumberland Superphosphate,	Cumberland Bone Company, Portland, Me.,	Lowell.
105	Manure for Light Soils,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Fitchburg.
111	Alkaline Bone,	E. Frank Coe, New York, N. Y.,	Mansfield.
112	Cleveland Superphosphate,	Cleveland Dryer Company, Boston, Mass.,	So. Framingham.
118	Eclipse Phosphate,	Bradley Fertilizer Company, Boston, Mass.,	Palmer.
119	Potato Fertilizer,	J. J. H. Gregory & Son, Marblehead, Mass.,	Amherst.
123	Market Garden Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Fall River.
130	Complete Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
131	Good Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Dighton.
136	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Fall River.
138	Fish and Potash,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
140	Nitrogenous Superphosphate,	J. C. Dow & Co., Boston, Mass.,	Dighton.
166	High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	Greenfield.
169	Standard Phosphate,	Read Fertilizer Company, Syracuse, N. Y.,	Pittsfield.
173	Ammoniated Bone Superphosphate,	Preston's Fertilizer Company, Greenpoint, L. I.,	Williamstown.
184	Dry Ground Fish,	Bradley Fertilizer Company, Boston, Mass.,	Greenfield.

185	Fine Wrapper Tobacco Grower,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
190	Standard Potato and Tobacco Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Greenfield.
193	Tobacco Starter,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Greenfield.
195	High-grade Special,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
205	Fish and Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
214	Tobacco Fertilizer,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
216	Potato, Onion and Tobacco Fertilizer,	Leander Wilcox, Mystic, Conn.,	Amherst.
217	Ammoniated Bone Superphosphate,	Leander Wilcox, Mystic, Conn.,	Amherst.
223	Tobacco Starter,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	South Deerfield.
224	Havana Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	South Deerfield.
234	Tobacco Fertilizer,	Clark's Cove Fertilizer Company, Boston, Mass.,	Agawam.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
91	Quinnipiac Phosphate,	14.41	2.56	2.47—3.30	7.14	2.21	1.45	10.80	10—14	9.35	9—12	2.32	2—3*
96	Cumberland Superphosphate,	16.43	2.79	2.06—2.88	6.22	2.91	2.43	11.56	10—12	9.13	8—10	2.01	2—3*
105	Manure for Light Soils,	10.70	4.90	4.04—6.59	5.19	2.77	2.29	10.25	8—10	7.96	6—8	7.38	6—8
111	Alkaline Bone,	11.13	1.03	1—1.5	7.42	.58	2.84	10.84	9—12	8.00	7—9	2.59	1.62—2.16*
112	Cleveland Superphosphate,	17.77	2.09	2.05—2.85	7.16	2.05	1.51	10.72	11—14	9.21	9—11	3.31	2—3*
118	Eclipse Phosphate,	13.60	2.54	1—2	3.27	6.40	1.49	11.16	12—15	9.67	10—12	2.84	1.5—2.5*
119	Potato Fertilizer,	7.65	4.09	4.12—4.94	2.70	2.42	2.30	7.42	7	5.12	5—6	12.70	13*
123	Market Garden Manure,	12.48	3.08	3.30—4.12	5.28	2.80	.90	8.98	9—13	8.08	8—11	7.13	7—8*
130	Complete Corn Manure,	11.31	3.98	3.71	3.43	2.84	1.89	8.16	-	6.27	5	7.10	7.5
131	Gold Brand Excelsior Guano,	8.92	2.23	2.5—3.5	6.60	2.00	2.56	11.16	9—13	8.60	8—11	8.21	6—8*
136	Potato and Root Crop Manure,	12.00	2.61	3—4	4.71	3.45	5.12	13.28	10—12	8.16	6—8	6.72	7—8
138	Fish and Potash,	28.81	3.64	3.71	2.17	2.66	.90	5.73	5—7	4.83	-	5.26	5—6
140	Nitrogenous Superphosphate,	16.69	3.11	2.06—2.88	5.76	3.32	1.28	10.36	-	9.08	8—10	3.35	1.89—2.52
166	Bradley's High grade Tobacco Manure,	6.18	5.81	5.77—6.59	1.84	2.41	1.71	5.96	4—5	4.25	-	14.08	10.80—12.42*

169	Standard Phosphate,	14.17	1.06	.82—1.65	3.10	6.65	.23	9.98	10—12	9.75	8—10	4.17	4—6*
173	Ammoniated Bone Superphosphate,	9.20	3.65	2.47—3.30	1.56	4.58	1.89	8.03	8—11	6.14	-	3.09	2—3
184	Dry Ground Fish,	15.63	8.33	7.41—9.06	1.28	2.95	2.04	6.27	7—9	4.23	-	-	-
185	Fine Wrapper Tobacco Grower,	6.30	5.84	5.77—6.59	1.41	2.82	2.81	7.04	6—9	4.23	5—7	9.96	10—12
190	Standard Potato and Tobacco Fertilizer,	13.86	1.83	2.05—2.88	7.01	1.33	2.42	10.76	9—13	8.34	-	3.69	3—4
193 223	Tobacco Starter,	10.35	2.85	2.47—3.30	6.42	2.46	4.22	13.10	12—16	8.88	-	3.90	2.5—3.5
195	High-grade Special,	12.45	3.66	3.71—4.11	7.09	.94	.59	8.62	8—11	8.03	7—9	7.83	7—9
205	Fish and Potash,	7.48	2.91	3.30—4.12	2.15	2.00	3.63	7.78	6—8	4.15	-	5.64	5—6
214	Tobacco Fertilizer,	11.32	4.53	3.30—4.94	7.65	1.14	.60	9.39	10—12	8.79	8—10	5.07	5.40—6.48*
216	Potato, Onion and Tobacco Manure,	14.44	3.35	3.25—4.25	4.86	2.20	1.79	8.85	8—9	7.06	7—8	6.72	6—7
217	Ammoniated Bone Superphosphate,	15.53	2.87	2.5—3.5	3.74	2.43	1.74	7.91	7—8	6.17	6—7	5.72	5—6
224	Havana Tobacco Fertilizer,	6.10	6.16	5.77—6.59	1.70	2.27	2.49	6.46	6—9	3.97	5—7	6.68	10—12*
234	Tobacco Fertilizer,	5.60	6.38	5.77—6.59	1.41	2.94	3.45	7.80	-	4.35	5—7	10.37	10—12

* Sulphate of potash, the source of potash

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
3	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
5	Connecticut Wrapper Fertilizer, "Pinney Formula,"	Cleveland Linseed Oil Company, Cleveland, Ohio,	Amherst.
29	Tankage,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
45	Vegetable Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
46	Complete Manure for Potatoes and Vegetables,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
48	Potato Manure,	J. G. Jefferds, Worcester, Mass.,	Worcester.
62	Breck's Lawn and Garden Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
72	Fruit and Vine Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y,	Boston.
75	West Andover Market Bone Phosphate,	J. E. McGovern, West Andover, Mass.,	Lawrence.
85	Tobacco and Potato Fertilizer,	Clark's Cove Fertilizer Company, Boston, Mass.,	Lawrence.
87	Lawn Dressing,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
94	Sure Crop Bone Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Amesbury.
97	Cumberland Potato Fertilizer,	Cumberland Bone Phosphate Company, Portland, Me.,	Lowell.
101	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Fitchburg.
103	Farm and Garden Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Fitchburg.
109	Fertilizer for Grass and Grain,	Great Eastern Fertilizer Company, Rutland, Vt.,	Mansfield.
117	Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Palmer.

145	Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Dighton.
152	Lawn Dressing,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
160	West Andover Market Bone Phosphate,	J. E. McGovern, West Andover, Mass.,	Amherst.
198	Ammoniated Bone Superphosphate,	E. Frank Coe, New York, N. Y.,	Williamstown.
207	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
222	Connecticut Wrapper Fertilizer, "Pinney Formula,"	Cleveland Linseed Oil Company, Cleveland, Ohio,	Amherst.
	Bones.		
26	Pure Raw Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
67	Fine-ground Bone,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
70	Pure Fine-ground Bone,	C. A. Bartlett, Worcester, Mass.,	Boston.
88	Fine-ground Bone,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Newburyport.
113	Fine-ground Bone,	Bradley Fertilizer Company, Boston, Mass.,	Palmer.
126	Meat and Bone,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
146	White Oak Pure Ground Bone,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
170	Quinnipiac Pure Ground Bone,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
3, 207	Banner Fertilizer,	11.39	1.62	2.06—2.88	5.88	2.81	4.61	13.30	11—12	8.69	9—10	1.06	1—2
5, 222	Connecticut Wrapper Fertilizer, "Pinney Formula,"	6.53	4.22	4.50—5.25	-	3.84	1.74	5.58	5.70—6.20	3.84	-	11.20	10 -11*
29	Tankage,	8.78	5.99	6.18—6.59	-	5.64	6.52	12.16	10—11	5.64	-	-	-
45	Vegetable Manure,	10.78	4.57	4.94—6.59	5.62	2.56	1.62	9.80	8—10	8.18	6—8	7.40	6—8
46	Complete Manure for Potatoes and Vegetables,	12.17	3.47	3.73—4.52	6.70	2.00	.82	9.52	9—13	8.70	8—11	6.23	6—7
48	Potato Manure,	12.70	2.00	2.47—3.30	5.17	3.76	6.32	15.35	15—17	8.93	10—12	4.98	5—6
62	Breck's Lawn and Garden Dressing,	9.55	3.95	4.12—4.94	3.86	2.07	2.05	7.98	-	5.93	5—6	5.47	5—6
72	Fruit and Vine Manure,	8.46	2.42	1.65—2.47	5.73	2.46	1.48	9.67	7—9	8.19	5—7	12.02	11—12
75, 160	West Andover Market Bone Phosphate,	14.92	2.10	1.50—2.50	4.22	9.64	1.74	15.60	13—15	13.86	-	3.92	2—4
85	Tobacco and Potato Fertilizer,	14.19	2.01	2.06—2.88	6.60	3.22	1.54	11.36	9—13	9.82	8—11	3.67	3—4*
87, 152	Crocker's Lawn Dressing,	8.53	3.18	4.12—4.94	.27	9.16	13.87	23.30	18—20	9.43	-	3.45	3.24—4.32*

94	Sure Crop Bone Phosphate,	13.55	.95	.82—1.65	7.96	2.76	3.07	13.79	10—12	10.72	5—6	2.09		1—2*	
97	Cumberland Potato Fertilizer,	15.67	2.34	2.06—2.88	6.91	3.58	1.79	12.28	11—13	10.49	9—11	3.55		3—4*	
101	Corn Manure,	12.73	2.28	2.06—2.88	6.90	3.46	2.12	12.48	10—14	10.36	9—12	1.64		1.50—2.50*	
103	Farm and Garden Phosphate,	11.11	2.51	1.65—2.47	6.45	1.74	3.48	11.67	12—14	8.19	8—10	2.39		2—3*	
109	Fertilizer for Grass and Grain,	15.91	3.48	2.88—3.71	5.98	2.36	1.48	9.82	-	8.34	8—12	2.20		2—4	
117, 145, 198	Ammoniated Bone Superphosphate,	10.40	1.88	2	7.43	1.24	3.07	11.74	11—15	8.67	9—12	1.75		1.85*	
												Mechanical Analysis.			
	Bones.											Fine.	Med. Fine.	Med	Coarse Med.
26	Pure Raw Ground Bone,	10.07	3.61	3.30—3.71	-	7.58	15.86	23.44	22—26	7.58	-	13.46	41.23	3.68	1.63
67, 113	Fine-ground Bone,	9.21	3.79	2.50—3.25	.18	5.86	13.44	19.48	21—23	6.04	-	40.14	37.42	22.44	-
70	Pure Fine-ground Bone,	3.55	2.63	3—4	.51	9.98	15.61	26.10	24—26	10.49	-	55.85	27.73	16.00	.42
88	Fine-ground Bone,	9.06	2.61	3.50—4.50	.15	9.49	14.05	23.79	22—25	9.64	-	73.02	18.62	8.36	-
126	Meat and Bone,	5.48	4.47	4.24	-	6.93	12.96	19.89	19.52	6.93	6.73	-	-	-	-
146	White Oak Pure Ground Bone,	9.57	3.19	2.47—4.12	-	6.85	13.02	19.87	20—22	6.43	-	44.22	29.25	25.79	.74
170	Pure Ground Bone,	9.31	3.22	2.47—4.12	.26	7.02	12.54	19.82	20—25	7.28	-	51.94	26.49	21.57	-

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
2	Tobacco Special,	Walker, Stratman & Co , Pittsburg, Pa.,	Amherst.
89	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
120	General Combination Fertilizer,	J. J. H. Gregory & Son, Marblehead, Mass.,	Amherst.
133	Special Potato Manure,	Pacific Guano Company, Boston, Mass.,	Fall River.
135	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Brockton.
139	Bristol Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
142	Great Planet "A" Manure,	Clark's Cove Fertilizer Company, Boston, Mass ,	Dighton.
149	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
163	Ground Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Amherst.
167	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Pittsfield.
168	Tobacco and Sulphur Lawn Fertilizer,	F. C. Sturtevant, Hartford, Conn.,	Great Barrington.
172	Complete Grass Fertilizer,	National Fertilizer Company, Bridgeport, Conn.,	Pittsfield.
177	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Great Barrington.
203	Special Tobacco Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
209	Ground Bone and Potash,	E. Frank Coe, New York, N. Y.,	Hadley.

219	Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
231	Tobacco Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Northampton.
	Chemicals.		
8	Sulphate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
41	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
51	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
54	Sulphate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
134	Muriate of Potash,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
183	Sulphate of Potash,	Lucien Sanderson, New Haven, Conn.,	Greenfield.
232	Sulphate of Potash,	Clark's Cove Fertilizer Company, Boston, Mass.,	Agawam.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
2, 231	Tobacco Special,	10.50	3.46	2.47—3.30	5.42	.60	6.26	12.28	10—12	6.02	8—10	3.22	3—4
89, 149	Vegetable Bone Superphosphate,	11.90	5.03	5—6	5.08	.88	1.66	7.62	6—7	5.96	6.00—7.00	7.76	6—8*
120	General Combination Fertilizer,	7.51	3.14	3.29—4.12	1.84	3.17	2.97	7.98	8	5.01	6—7	12.17	12—13
133	Special Potato Manure,	18.84	2.78	2.47—3.30	4.91	1.82	2.05	8.78	7—10	6.73	5—7	5.10	5—6
135, 168	Tobacco and Sulphur Lawn Fertilizer,	13.23	1.95	1.96	-	-	-	.83	.75	-	-	8.11	7.66
139	Bristol Fish and Potash,	12.55	2.05	1.60—2.50	6.38	1.62	4.12	12.12	8—10	8.00	5—8	2.60	2—3*
142	Great Planet "A" Manure,	11.65	3.88	3.30—4.12	4.61	3.24	1.41	9.26	9—13	7.85	8—11	7.26	7—8*
163	Ground Bone Fertilizer,	7.91	2.32	2.06—2.47	.83	2.44	16.35	19.62	18—22	3.27	-	2.07	1.62—1.89*
167, 177	Ammoniated Bone Superphosphate,	7.42	1.90	1.65—2.47	1.75	4.67	5.14	11.56	9—11	6.42	7—9	3.88	2—4
172	Complete Grass Fertilizer,	13.27	4.25	4.12—4.94	7.32	2.15	.61	10.08	6—8	9.47	4—6	6.42	5—7

203	Special Tobacco Manure,	6.71	4.54	4.53—5.36	3.38	1.22	1.23	5.83	-	4.60	-	11.25	10—12*
209	Ground Bone and Potash,	9.71	1.57	2—2.50	.72	6.06	8.57	15.35	10.99-11.91	6.78	-	2.71	2.75*
219	Dry Ground Fish Guano,	8.51	8.52	8—10	.59	3.45	3.51	7.55	-	6.96	4—6	-	-
	Chemicals.												
8	Sulphate of Potash,	2.00	-	-	-	-	-	-	-	-	-	29.10	-
41	Muriate of Potash,	1.57	-	-	-	-	-	-	-	-	-	51.40	48—55
51	Dissolved Bone-black,	15.72	-	-	12.95	2.22	.19	15.36	15.35	15.17	15.29	-	-
54	Sulphate of Potash,	6.00	-	-	-	-	-	-	-	-	-	26.52	25.93—28.10
134	Muriate of Potash,	1.75	-	-	-	-	-	-	-	-	-	48.90	-
183	Sulphate of Potash,	6.10	-	-	-	-	-	-	-	-	-	29.30	27.02—29.72
232	Sulphate of Potash,	.14	-	-	-	-	-	-	-	-	-	51.00	48.65—51.35

* Sulphate of potash, the source of potash.

1. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
4	Four-fold Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
15	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
20	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
23	Complete Manure for Top-dressing Grass,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
31	Superphosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
33	A. A. Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Springfield.
37	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
60	Fish and Potash,	Bradley Fertilizer Company, Boston, Mass.,	North Amherst.
66	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Boston.
78	Royal Bone Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
79	Prolific Crop Producer,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
84	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Lawrence.
95	Farmers' New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
116	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	So. Framingham.
208	Four-fold Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
	Chemicals.		
6	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
7	Dissolved Bone-black,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.

25	Nitrate of Soda,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
30	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
38	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
39	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
44	Sulphate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
58	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
59	Muriate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
137	Nitrate of Soda,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
180	Nitrate of Soda,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
181	Dissolved Bone-black,	Lucien Sanderson, New Haven, Conn.,	Greenfield.
182	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Greenfield.
194	Sulphate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
196	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Greenfield.
211	Sulphate of Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
233	Sulphate of Potash,	Clark's Cove Fertilizer Company, Boston, Mass.,	Agawam.
	Bones.		
63	Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Boston.
104	Pure Ground Bone,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Fitchburg.
107	Pure Ground Bone,	John C. Dow & Co., Boston, Mass.,	Lowell.
114	Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	So. Framingham.
161	Pure Ground Bone,	John C. Dow & Co., Boston, Mass.,	Amherst.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4, 208	Four-fold Fertilizer,	10.88	1.65	1.65—2.47	4.55	2.98	4.27	11.80	10—11	7.53	8—9	4.32	2—3
15, 20	Potato Manure,	13.10	2.55	2.50—3.25	4.06	2.67	1.94	8.67	8—11	6.73	6—8	4.93	5—6
23	Complete Manure for Top-dressing Grass,	6.60	4.48	4.62—4.94	.76	3.35	1.77	5.88	7—8	4.11	4—5	8.04	8—10
31	Superphosphate,	16.06	2.32	2.47—3.30	4.96	3.81	3.20	11.97	10—12	8.77	8—10	3.01	3—4
33	A. A. Ammoniated Superphosphate,	13.77	2.72	2.47—3.30	7.69	2.13	.84	10.66	10.25—14.5	9.82	10—12	2.79	2—3
37, 84	Lawn and Garden Dressing,	9.33	4.10	4—5	5.84	1.82	4.46	12.12	6—8	7.66	5—6	7.68	5—6
[illegible]	Fish and Potash,	22.04	2.38	2.48—3.50	2.50	3.28	1.51	7.29	7.5—8.5	5.78	6—8	2.67	2—3
[illegible]	Hill and Drill Phosphate,	12	2.95	2.5—3.25	6.52	3.96	2.56	13.04	11—15	10.48	10—13	2.65	2—3
78	Royal Bone Phosphate,	19.26	.95	1.03—1.65	5.25	3.12	2.15	10.52	8—11	8.37	7—9	2.48	2—3*
79	Prolific Crop Producer,	18.73	1.02	.82—1.64	5.01	3.21	2.17	10.39	7—11	8.22	6—9	2.73	1—2
95	Farmers' New Method Fertilizer,	16.85	1.18	1—2	5.42	2.61	1.69	9.72	10—13	8.03	8—10	2.29	2.16—2.70*
	Chemicals.												
6	Nitrate of Soda,	1.30	16.17	-	-	-	-	-	-	-	-	-	-

7	Dissolved Bone-black,	15.66	-	-	10.54	1.76	.44	12.74	-	12.30	-	-	-
25	Nitrate of Soda,	1.12	16.04	14.83—16.48	-	-	-	-	-	-	-	-	-
30	Nitrate of Soda,	.92	16.12	15.81—16.14	-	-	-	-	-	-	-	-	-
38	Muriate of Potash,	.02	-	-	-	-	-	-	-	-	-	54.10	53.70—56.86
39	Dissolved Bone-black,	16.25	-	-	15.42	.68	.18	16.28	17—18	16.10	-	-	-
44	Sulphate of Potash,	.55	-	-	-	-	-	-	-	-	-	49.70	48—52
58	Nitrate of Soda,	1.75	16.05	15.65—16.14	-	-	-	-	-	-	-	-	-
59	Muriate of Potash,	.12	-	-	-	-	-	-	-	-	-	52.20	50.54—53.70
137	Nitrate of Soda,	.85	16.03	15.66	-	-	-	-	-	-	-	-	-
180	Nitrate of Soda,	1.55	15.85	14.87—16.06	-	-	-	-	-	-	-	-	-
181	Dissolved Bone-black,	14.00	-	-	15.86	.43	2.43	18.72	16—18	16.29	-	-	-
182	Nitrate of Soda,	2.37	16.11	14.90—16.48	-	-	-	-	-	-	-	-	-
194	Sulphate of Potash,	1.35	-	-	-	-	-	-	-	-	-	49.40	-
196	Muriate of Potash,	1.19	-	-	-	-	-	-	-	-	-	52.05	50.54—53.70
211	Sulphate of Potash,	1.45	-	-	-	-	-	-	-	-	-	46.30	-
233	Sulphate of Potash,	3.01	-	-	-	-	-	-	-	-	-	25.50	25.93—28.10

Bones.

												Mechanical Analysis.			
												Fine.	Med. Fine.	Med.	Coarse Med.
63, 114	Fresh Ground Bone,	5.98	3.23	2.47—3.30	2.89	13.07	2.97	18.83	18—22	15.96	5—7	33.10	31.39	26.27	9.24
104	Pure Ground Bone,	8.57	3.87	3.5—4.5	-	3.42	22.08	25.50	24—26	3.42	-	.53	29.46	55.37	14.64
107, 161	Pure Ground Bone,	3.43	1.79	1.65—2.47	.20	16.82	10.69	27.71	24—26	17.02	-	58.24	38.06	3.70	-

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	NAME OF BRAND.	NAME OF MANUFACTURER.	Sampled at —
	Compound Fertilizers.		
99	Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
115	Potato Phosphate,	Cleveland Dryer Company, Boston, Mass.,	So. Framingham.
121	Corn Fertilizer,	J. J. H. Gregory & Son, Marblehead, Mass.,	Amherst.
132	Dry Ground Menhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Fall River.
143	High-grade Special,	Williams & Clark Fertilizer Company, Boston, Mass.,	Dighton.
144	Fish and Potash,	Clark's Cove Fertilizer Company, Boston, Mass.,	Dighton.
151	Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
156	Ammoniated Practical Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
158	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Amherst.
164	Canada Hardwood Unleached Ashes,	Allison, Stroup & Co., Boston, Mass.,	Williamstown.
175	New England Favorite,	J. S. Reese & Co., Baltimore, Md.,	Pittsfield.
176	Fish and Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
178	Grass Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Pittsfield.
179	Complete Fertilizer for Potatoes,	National Fertilizer Company, Bridgeport, Conn.,	Pittsfield.
186	Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
187	Bay State Fertilizer (G. G. Brand),	Clark's Cove Fertilizer Company, Boston, Mass.,	Greenfield.

189	Grass Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
191	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Great Barrington.
192	Lawn Dressing,	Williams & Clark Fertilizer Company, Boston, Mass.,	North Adams.
197	Blood, Meat and Bone,	Lucien Sanderson, New Haven, Conn.,	Greenfield.
200	Superphosphate No. 2,	Preston Fertilizer Company, Greenpoint, L. I.,	Williamstown.
202	Fine Dry Ground Fish,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
204	Complete Grass Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
206	Dry Ground Fish,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
210	Excelsior Tobacco Grower,	E. Frank Coe, New York, N. Y.,	Hadley.
212	High-grade Fish Guano and Potash,	E. Frank Coe, New York, N. Y.,	Hadley.
213	Dry Ground Fish,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
220	Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
221	Corn Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Amherst.
235	Potato Special,	J. S. Reese & Co., Baltimore, Md.,	Chicopee.
236	Whittemore's Complete Manure,	Whittemore Bros., Wayland, Mass.,	Amherst.

4. Analyses of Licensed Fertilizers, etc. — *Concluded.*

Laboratory Number	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
99, 151, 186	Wheat and Corn Phosphate,	14.61	1.78	2—3	7.32	2.50	2.05	11.87	11—15	9.82	10—13	1.82	1.6—2.7*
115	Potato Phosphate,	16.68	2.23	2—2.25	7.22	1.91	1.69	10.82	9—13	9.13	8—10	3.81	3—4*
121	Corn Fertilizer,	6.85	3.12	3.09	1.25	4.71	2.41	8.37	7	5.96	5.5	12.96	15
132	Dry Ground Menhaden Fish Guano,	9.77	8.86	8.24—9.89	.56	3.23	3.17	6.96	6.87—9.16	3.79	-	-	-
143	High-grade Special,	11.26	3.68	3.30—4.12	7.60	1.22	.90	9.72	8—11	8.82	7—9	7.90	7—9
144	Fish and Potash,	21.96	2.65	2.47—4.12	2.97	2.58	1.82	7.37	7—9	5.55	6—8	2.61	3—5*
156	Ammoniated Practical Superphosphate,	12.31	1.14	.82—1.64	5.95	.62	2.38	8.94	8—10	6.57	8—10	1.31	1—2
158	New Rival Ammoniated Superphosphate,	16.18	1.43	1.20—2	7.42	2.18	1.66	11.26	10—12	9.60	10—12	1.58	1.60—3
164	Canada Hardwood Unleached Ashes,	8.88	-	-	-	-	-	1.79	1.36—1.83	-	-	8.26	5.84—6.80
175	New England Favorite,	18.97	2.45	2.47—3.30	4.78	4.24	1.54	10.56	11—14	9.02	9—12	2.04	2—3
176	Fish and Potash,	22.34	2.10	2.06—2.88	2.64	3.27	1.02	6.93	6—9	5.91	4—6	4.61	4—6*
178, 189	Grass Fertilizer,	9.81	4.26	3.91—4.74	2.25	3.73	2.00	7.98	6—8	5.98	5—7	3.25	2—3*

179	Complete Fertilizer for Potatoes,	12.93	4.60	3.30—4.12	7.12	2.64	.30	10.06	10—12	9.76	8—10	5.44	6—8
187	Bay State Fertilizer (G. G. Brand),	13.58	2.09	1.85—2.68	6.45	2.05	1.92	10.44	10—13	8.50	8.5—11	2.13	2—3*
191	Standard Fertilizer,	15.46	2.00	2—3	6.60	2.99	1.54	11.13	10—15	9.59	8—12	2.27	2—3
192	Lawn Dressing,	8.78	4.31	4.95—5.78	1.90	3.60	1.28	6.78	6—8	5.50	5—7	3.36	2.5—3.5
197	Blood, Meat and Bone,	6.30	5.54	5.77—7.41	.38	3.58	5.12	9.08	10.12	3.96	-	-	-
200	Superphosphate No. 2,	15.33	1.71	.82—1.65	7.70	1.80	1.02	10.52	-	9.50	10—12	2.23	1—2
202	Fine Dry Ground Fish,	15.96	8.32	8—10	.51	4.09	1.51	6.14	7—8	4.60	-	-	-
204	Complete Grass Manure,	11.00	3.60	3.71	2.41	3.99	1.33	7.73	-	6.40	3	7.69	7
206 213	Dry Ground Fish,	16.77	8.17	8.24—9.89	.40	5.34	1.76	7.50	6—8	5.74	-	-	-
210	Excelsior Tobacco Grower,	7.84	3.10	3—4	8.75	1.53	1.64	11.92	8—11	10.28	8—11	4.93	5—6*
212	High-grade Fish Guano and Potash,	10.78	2.73	3.30—4.10	2.46	4.20	3.08	9.74	7—11	6.66	6—9	2.92	2.75*
220	Fish and Potash,	13.15	3.44	3.25—4.25	2.38	2.71	1.46	6.55	6—7	5.09	5—6	4.45	4—5
221	Corn Phosphate,	14.52	2.52	2.06—2.88	7.16	4.38	2.22	13.76	10.25—14	11.54	9—12	1.62	1.5—2.5
235	Potato Special,	14.11	2.72	2.88—3.71	7.78	1.95	.20	9.93	-	9.73	6—8	7.65	7.5—9.5
236	Whittemore's Complete Manure,	11.69	3.30	2.47—3.30	6.24	5.86	1.84	13.94	12—14	12.10	8.12	4.30	3—4

* Sulphate of potash, the source of potash.

5. Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.

Wood Ashes.

[I., sent on from Marblehead, Mass.; II., sent on from Westminster, Mass.; III., sent on from South Sudbury, Mass.; IV., sent on from South Deerfield, Mass.; V., sent on from Concord, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	18.06	6.51	4.80	4.67	15.40
Potassium oxide,	4.17	5.27	3.42	2.12	7.73
Calcium oxide,	24.68	38.92	43.40	49.36	34.27
Phosphoric acid,	.79	1.23	1.71	.61	1.13
Insoluble matter (before calcination),	27.66	21.09	10.51	5.63	12.45
Insoluble matter (after calcination),	25.06	19.32	9.02	4.04	11.11

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Rock Bottom, Mass.; IV. and V., sent on from Sunderland, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	11.39	7.87	19.85	11.15	16.17
Potassium oxide,	8.39	5.56	3.66	5.83	5.94
Calcium oxide,	33.05	37.93	–*	–*	–*
Phosphoric acid,	1.74	.74	.95	1.83	Trace
Insoluble matter (before calcination),	16.11	19.02	16.89	23.85	31.13
Insoluble matter (after calcination),	14.27	17.64	13.24	18.17	20.02

* Not determined.

Wood Ashes.

[I. and II., sent on from Lowell, Mass.; III. and IV., sent on from Boston, Mass.; V., sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.30	3.39	16.59	9.51	24.63
Potassium oxide,	4.97	5.52	6.45	5.72	7.63
Phosphoric acid,	.46	2.41	.77	.56	.82
Insoluble matter (after calcination),	17.98	15.72	6.02	13.25	.46

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I , sent on from Tewksbury, Mass.; II. and III., sent on from Concord, Mass.; IV. and V., sent on from North Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	11.30	15.01	8.49	18.13	14.25
Potassium oxide,	6.80	8.05	7.10	5.05	5.95
Phosphoric acid,	1.69	.67	.31	.92	1.43
Insoluble matter (before calcination),	16.56	18.38	16.97	15.33	15.03
Insoluble matter (after calcination),	13.66	15.84	15.25	13.46	12.75

Wood Ashes.

[I., sent on from Winchendon, Mass.; II., sent on from North Hadley, Mass.; III., sent on from Concord, Mass. ; IV., sent on from Framingham, Mass.; V., sent on from North Sudbury, Mass.]

	Per Cent.				
	I	II.	III.	IV.	V.
Moisture at 100° C.,	23.07	4.48	16.16	16.39	17.74
Potassium oxide,	2.87	6.75	5.88	4.83	6.45
Calcium oxide,	33.04	37.32	32.46	35.52	33.76
Phosphoric acid,	1.48	1.82	1.07	1.33	1.00
Insoluble matter (before calcination),	10.96	15.53	15.34	10.07	13.37
Insoluble matter (after calcination),	9.29	13.72	13.09	9.28	12.13

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Eastham, Mass ; IV., sent on from Westborough, Mass.; V., sent on from Sunderland, Mass]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.96	13.00	15.33	20.57	19.52
Potassium oxide,	3.00	8.74	5.96	5.93	6.21
Calcium oxide,	25.60	36.44	36.14	32.03	29.51
Phosphoric acid,	.97	1.79	.26	1.48	1.83
Insoluble matter (before calcination),	36.93	8.44	12.91	10.05	13.47
Insoluble matter (after calcination),	34.89	6.40	10.38	8.09	10.85

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I. and II., sent on from Waltham, Mass.; III., sent on from Westminster, Mass.; IV. and V., sent on from Montague, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.97	23.75	3.13	16.53	26.80
Potassium oxide,	6.86	4.68	4.73	4.24	4.00
Phosphoric acid,	1.56	.90	1.33	1.15	1.20
Insoluble matter (after calcination),	17.07	17.43	22.03	15.73	13.55

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from North Amherst, Mass.; IV., sent on from Hadley, Mass; V., sent on from Sudbury, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	20.98	9.39	17.35	13.43	11.48
Potassium oxide,	3.23	7.64	7.07	5.76	4.10
Calcium oxide,	46.44	39.00	35.51	–*	–*
Phosphoric acid,	1.02	1.69	1.64	1.54	1.66
Insoluble matter (before calcination),	15.73	15.44	8.60	–*	–*
Insoluble matter (after calcination),	14.10	13.95	6.30	10.23	15.33

Wood Ashes.

[I. and II., sent on from North Amherst, Mass.; III, sent on from Westborough, Mass.; IV., sent on from Acton, Mass.; V., sent on from South Framingham, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.21	11.28	5.50	23.49	6.58
Potassium oxide,	5.99	6.81	6.93	3.56	4.79
Calcium oxide,	39.48	40.24	45.20	–*	–*
Phosphoric acid,	1.13	1.28	1.41	1.25	1.02
Insoluble matter (before calcination),	10.33	10.58	10.57	11.02	–*
Insoluble matter (after calcination),	9.15	9.33	8.57	9.11	12.49

* Not determined.

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I. and II., sent on from South Sudbury, Mass.; III. and IV., sent on from Concord, Mass.; V., sent on from Acton, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.61	20.80	10.85	17.09	21.30
Potassium oxide,	5.24	4.19	4.33	5.00	4.00
Phosphoric acid,	1.20	.67	3.75	1.05	1.13
Insoluble matter (before calcination),	29.60	25.39	12.00	18.42	8.97

Wood Ashes.

[I. and II., sent on from Southampton, Mass.; III. and IV., sent on from Concord, Mass.; V., sent on from Sunderland, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.72	16.75	13.00	22.21	37.56
Potassium oxide,	5.72	4.58	9.46	4.40	1.51
Calcium oxide,	–*	–*	35.88	34.24	–*
Phosphoric acid,	.38	1.51	1.13	.56	.67
Insoluble matter (before calcination),	–*	–*	8.72	16.15	–*
Insoluble matter (after calcination),	7.22	26.37	6.90	13.65	10.38

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from East Whately, Mass.; IV., sent on from West Northfield, Mass.; V., sent on from Sunderland, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	19.43	14.04	11.06	5.04	21.83
Potassium oxide,	4.55	6.57	4.81	6.35	6.12
Calcium oxide,	35.48	34.55	–*	–*	–*
Phosphoric acid,	.81	1.60	.82	1.54	1.74
Insoluble matter (before calcination),	17.58	13.50	–*	–*	–*
Insoluble matter (after calcination),	14.79	11.28	5.76	13.55	11.78

* Not determined.

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Hadley, Mass.; IV., sent on from Sunderland, Mass.; V., sent on from West Northfield, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	14.16	16.19	10.44	15.79	10.44
Potassium oxide,	5.78	6.36	6.38	6.86	5.46
Calcium oxide,	32.47	34.16	–*	–*	–*
Phosphoric acid,	1.61	1.00	1.28	.95	.05
Insoluble matter (before calcination),	15.46	14.35	–*	–*	–*
Insoluble matter (after calcination),	13.06	12.27	23.08	18.17	25.08

* Not determined.

Wood Ashes.

[I. and II., sent on from West Northfield, Mass; III., sent on from Amherst, Mass.; IV., sent on from Boston, Mass.; V., sent on from Pelham, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.92	5.36	9.52	8.11	11.22
Potassium oxide,	5.07	7.00	4.31	4.88	4.95
Phosphoric acid,	1.07	1.97	1.23	1.31	1.64
Insoluble matter (after calcination),	21.19	18.65	14.35	16.18	15.21

Wood Ashes.

[I. and II, sent on from Concord, Mass.; III., sent on from Danvers, Mass.; IV., sent on from Amherst, Mass.; V., sent on from Westborough, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	16.38	9.90	10.49	16.18	15.33
Potassium oxide,	6.55	7.44	5.57	3.39	6.25
Phosphoric acid,	.51	1.71	1.07	1.28	1.20
Insoluble matter (after calcination),	10.16	16.79	11.25	15.36	9.07

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Hudson, Mass.; IV., sent on from Hingham, Mass.; V., sent on from Granby, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.87	11.22	17.70	2.37	11.07
Potassium oxide,	4.82	4.10	4.13	4.79	4.40
Calcium oxide,	37.00	32.60	33.20	32.80	42.80
Phosphoric acid,	1.40	1.28	1.28	1.16	1.80
Insoluble matter (after calcination),	22.81	18.06	14.31	30.38	13.91

Wood Ashes.

[I. and II., sent on from North Amherst, Mass.; III., sent on from South Deerfield, Mass.; IV., sent on from Concord, Mass.; V., sent on from South Sudbury, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	.30	1.65	3.60	7.35	29.48
Potassium oxide,	5.30	9.22	5.56	4.74	2.38
Calcium oxide,	–*	–*	41.97	42.40	37.71
Phosphoric acid,	3.08	1.54	.77	1.66	1.08
Insoluble matter (after calcination),	5.12	10.90	21.23	16.78	3.75

Wood Ashes.

[I., sent on from Amherst, Mass.; II. and III., sent on from Hadley, Mass.; IV., sent on from North Amherst, Mass.; V., sent on from West Northfield, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.57	16.85	30.38	18.05	9.19
Potassium oxide,	7.63	5.88	4.48	4.04	5.70
Calcium oxide,	32.51	36.42	26.55	–*	36.00
Phosphoric acid,	1.45	1.51	1.22	1.15	1.41
Insoluble matter (after calcination),	32.57	4.46	11.01	11.41	12.58

* Not determined.

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I., sent on from Marlborough, Mass.; II., sent on from Amherst, Mass.; III., IV. and V., sent on from Marblehead, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	2.98	4.21	20.97	12.72	11.30
Potassium oxide,	4.98	3.82	5.12	5.48	4.60
Calcium oxide,	37.26	31.14	31.80	37.00	40.40
Phosphoric acid,	1.15	2.98	.70	1.22	1.79
Insoluble matter,	25.25	18.97	14.73	15.12	10.60

Wood Ashes.

[I., sent on from Hudson, Mass.; II., sent on from Hingham, Mass.; III. and IV., sent on from Granby, Mass.; V., sent on from Amesbury, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	17.70	2.37	11.07	1.17	10.41
Potassium oxide,	4.13	4.79	4.40	4.31	4.33
Calcium oxide,	33.20	32.80	42.80	25.60	32.67
Phosphoric acid,	1.28	1.16	1.80	1.54	.90
Insoluble matter,	14.31	30.38	13.91	39.49	16.65

Wood Ashes.

[I., sent on from Merrimac, Mass.; II. and III., sent on from Boston, Mass.; IV., sent on from Clinton, Mass.; V., sent on from Fall River, Mass.]

	Per Cent.				
	I	II.	III.	IV.	V.
Moisture at 100° C.,	10.67	5.18	9.81	25.28	9.78
Potassium oxide,	5.74	5.93	4.90	3.72	4.71
Calcium oxide,	38.60	39.40	44.40	–*	–*
Phosphoric acid,	1.28	.96	1.66	1.25	1.51
Insoluble matter,	11.75	6.97	1.40	12.38	18.52

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Cotton-hull Ashes.

[I. and II., sent on from Boston, Mass.; III., sent on from Amherst, Mass.; IV., sent on from Agawam, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	9.87	7.77	14.78	13.92
Potassium oxide,	24.06	20.40	23.96	24.12
Phosphoric acid,	7.68	7.83	7.93	9.21
Insoluble matter,	15.38	11.78	10.10	9.33

Ashes from Cremation of Swill.

[Sent on from Lowell, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	.51	.07	.04	.11
Potassium oxide,	1.73	8.83	7.03	1.25
Calcium oxide,	24.79	28.18	33.74	47.60
Magnesium oxide,	1.87	—*	—*	—*
Ferric and aluminic oxides,	3.57	7.63	6.25	1.06
Phosphoric acid,	16.61	17.18	26.09	32.26
Insoluble matter (before calcination),	39.60	18.49	14.40	15.13
Insoluble matter (after calcination),	29.72	16.53	11.41	13.20

* Not determined.

Logwood Ashes.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	.55
Potassium oxide,	.26
Calcium oxide,	58.26
Magnesium oxide,	1.46
Ferric and aluminic oxides,	1.46
Phosphoric acid,	.70
Carbonic acid,	32.95
Insoluble matter,	3.09

Sewage.

[Sent on from Danvers, Mass.]

	Per Cent.
Moisture at 100° C.,	99.959
Potassium oxide,	.0033
Phosphoric acid,	.0012
Nitrogen,	.0028

5. Analyses, etc. — *Continued.*

Peat.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	27.51
Nitrogen,	.12

Florida Muck.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	5.94
Nitrogen,	1.07

Canal Mud.

[Sent on from North Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	60.93
Potassium oxide,	–
Phosphoric acid,	.28
Nitrogen,	.15
Insoluble matter,	32.67

Muck.

[I, sent on from Rockbottom, Mass.; II, sent on from Pansy Park, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	78.06	81.09
Nitrogen,	.43	.42

Horse Manure.

[Sent on from Westborough, Mass.]

	Per Cent.
Moisture at 100° C.,	11.25
Potassium oxide,	2.82
Phosphoric acid,	1.46
Nitrogen,	.74
Insoluble matter,	12.60

Boiler Soot.

[Sent on from Hatfield, Mass.]

	Per Cent.
Moisture at 100° C.,	18.80
Potassium oxide,	.54
Phosphoric acid,	1.60
Calcium oxide,	2.31
Magnesium oxide,	1.19
Insoluble matter,	58.91

5. ANALYSES, ETC. — *Continued.*

Castor Pomace.

[I., sent on from Amherst, Mass.; II., sent on from Hatfield, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	10.08	8.07
Potassium oxide,	3.40	–*
Phosphoric acid,	2.26	–*
Nitrogen,	5.60	5.22
Insoluble matter,	1.70	–*

* Not determined.

Muriate of Potash.

[I., sent on from North Amherst, Mass.; II., sent on from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C,	1.98	.30
Potassium oxide,	52.00	36 00
Insoluble matter,	.26	.18

Saltpetre.

[Sent on from South Acton, Mass.]

	Per Cent.
Moisture at 100° C.,	.66
Potassium oxide,	45.74
Nitrogen,	11.88

Saltpetre Waste.

[Sent on from Townsend Harbor, Mass.]

	Per Cent.
Moisture at 100° C.,	1.90
Potassium oxide,	6.24
Sodium oxide,	43.01
Chlorine,	43.69
Nitrogen,	1.56

Sulphate of Soda.

[Sent on from Denver, Col.]

	Per Cent.
Moisture at 100° C.,	1.38
Water of combination,	.99
Sulphuric acid,	54.93
Insoluble matter,	.16

5. ANALYSES, ETC. — *Continued.*

Nitrate of Soda.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	1.82
Nitrogen,	14.72
Insoluble matter,	.12

Carbonate of Potash.

[Sent on from Amherst, Mass.]

	Per Cent.
Water of combination,	26.88
Potassium oxide,	18.48
Magnesium oxide,	19.52
Insoluble matter,	.39

Odorless Phosphate.

[I., sent on from Hatfield, Mass.; II., sent on from Marshfield, Mass.; III., sent on from Amherst, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	1.12	.60	.63
Potassium oxide,	.32	.52	–*
Phosphoric acid,	18.40	19.45	18.42
Calcium oxide,	49.00	61.30	48.27
Carbonic acid,	2.67	2.25	–
Insoluble matter,	7.20	5.12	5.53

Concentrated Phosphates.

[I., double superphosphate; II., phosphate of ammonia; III., phosphate of potash; sent on from New York, N. Y.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	5.74	6.05	3.76
Potassium oxide,	–	–	32.56
Calcium oxide,	16.00	–	–
Total phosphoric acid,	47.80	43.86	35.70
Soluble phosphoric acid,	38.38	–*	–*
Reverted phosphoric acid,	9.04	–*	–*
Insoluble phosphoric acid,	.38	–*	–*
Nitrogen,	–	10.37	–
Insoluble matter,	.60	.82	.92

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Florida Phosphates.

[Sent on from Amherst, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	.95	2.52
Total phosphoric acid,	23.87	21.72
Soluble phosphoric acid,	.16	–*
Reverted phosphoric acid,	1.37	–*
Insoluble phosphoric acid,	22.34	–*
Insoluble matter,	31.77	30.50

South Carolina Floats.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	.83
Total phosphoric acid,	23.39
Soluble phosphoric acid,	Trace
Reverted phosphoric acid,	2.33
Insoluble phosphoric acid,	21.06
Insoluble matter,	20.16

Ground Bone.

[I., sent on from New Bedford, Mass.; II., sent on from Peabody, Mass.; III., sent on from Northborough, Mass.]

	PER CENT.		
	I.	II.	III.
Moisture at 100° C.,	5.94	4.62	4.85
Total phosphoric acid,	25.33	25.68	22.96
Soluble phosphoric acid,	.32	.52	.29
Reverted phosphoric acid,	15.16	18.23	9.77
Insoluble phosphoric acid,	9.85	6.93	12.90
Nitrogen,	2.96	2.18	4.02
Insoluble matter,	1.02	–*	.70

* Not determined.

5. Analyses, etc. — *Continued.*

Ground Bone.

[Sent on from Concord, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	9.23	8.71	3.21
Total phosphoric acid,	21.80	20.29	23.46
Soluble phosphoric acid,	–	–	.47
Reverted phosphoric acid,	12.96	10.20	12.21
Insoluble phosphoric acid,	8.84	10.09	10.78
Nitrogen,	3.54	3.70	3.22

Cotton-seed Meal.

[I., II. and III., sent on from Amherst, Mass.; IV. and V., sent on from Hatfield, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.65	7.78	6.48	6.47	7.08
Potassium oxide,	2.25	1.78	2.50	–*	–*
Phosphoric acid,	3.17	3.15	2.58	–*	–*
Nitrogen,	6.50	6.24	6.88	7.23	6.62

* Not determined.

Mill Sweepings.

[Sent on from Westborough, Mass.]

	Per Cent.
Moisture at 100° C.,	9.49
Potassium oxide,	.66
Phosphoric acid,	1.18
Nitrogen,	3.76
Insoluble matter,	5.01

Home-mixed Fertilizers.

[I., animal meal and tankage; II., tankage and potash, sent on from Eastham, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	3.20	6.20
Potassium oxide,	–	6.75
Phosphoric acid,	19.71	15.35
Nitrogen,	4.48	3.93

5. Analyses, etc. — *Concluded.*

Animal Fertilizers.

[I., sent on from New Bedford, Mass.; II., sent on from Boston, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	4.69	12.87
Total phosphoric acid,	13.22	9.08
Soluble phosphoric acid,	.19	–*
Reverted phosphoric acid,	7.72	–*
Insoluble phosphoric acid,	5.31	–*
Nitrogen,	1.75	8.16
Insoluble matter,	11.92	–

* Not determined.

Complete Fertilizers.

[I., sent on from Cleveland, Ohio; II., sent on from South Sudbury, Mass.; III., sent on from Springfield, Mass.; IV., sent on from West Berlin, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.50	11.25	12.47	11.03
Total phosphoric acid,	6.13	11.83	14.14	12.77
Soluble phosphoric acid,	.32	2.30	1.85	7.52
Reverted phosphoric acid,	5.30	8.95	9.78	3.24
Insoluble phosphoric acid,	.51	.58	2.51	2.01
Potassium oxide,	6.68	2.44	7.22	1.40
Nitrogen,	4.53	4.69	4.11	2.39

Complete Fertilizers.

[I. and II., sent on from North Hadley, Mass ; III. and IV., sent on from Hudson, Mass]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	6.00	7.62	9.87	4.34
Total phosphoric acid,	8.60	9.77	12.54	11.16
Soluble phosphoric acid,	3.74	3.22	4.96	4.76
Reverted phosphoric acid,	2.51	3.58	4.30	3.38
Insoluble phosphoric acid,	2.35	2.97	3.28	3.02
Potassium oxide,	5.59	6.64	5.99	6.66
Nitrogen,	2.29	2.46	3.20	3.94

6. Miscellaneous Analyses.

Oriental Fertilizer and Bug Destroyer.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	87.14
Solid matter,	12.86
Arsenic oxide,	2.38
Potassium oxide,	3.50
Sodium oxide,	6.08
Nitrogen,	.67
Chlorine,	3.00
Sulphuric acid,	.64

Non-poisonous Potato-bug Destroyer.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	None
Nitrogen,	.08
Ash,	79.85
Potassium oxide,	None
Calcium oxide,	68.20
Magnesium oxide,	7.29
Ferric and aluminic oxides,	1.38
Phosphoric acid,	Trace
Insoluble matter (before calcination),	7.29
Insoluble matter (after calcination),	1.50

Clay (so called).

[Sent on from Lynn, Mass.]

	Per Cent.
Moisture at 100° C.,	.70
Calcium oxide,	51.35
Magnesium oxide,	1.04
Ferric and aluminic oxides,	2.80
Phosphoric acid,	Trace
Carbonic acid,	37.30
Organic and volatile matter,	40.65
Insoluble matter,	2.57

6. Miscellaneous Analyses — *Concluded.*

Soil.

[Sent on from Springfield, Mass.]

	Per Cent. I.	Per Cent. II.
Moisture at 100° C.,	2.39	8.15
Potassium oxide,	.21	.15
Calcium oxide,	.56	.54
Phosphoric acid,	.18	.16
Nitrogen,	.154	.147

Wheat Flour.

[From station barn.]

	Per Cent.
Moisture at 100° C.,	14.46
Potassium oxide,	.179
Phosphoric acid,	.230
Nitrogen,	1.840

Buttermilk.

[Sent on from Shelburne, Mass.]

	Per Cent.
Moisture at 100° C.,	91.130
Nitrogen,	.510
Ash,	.810
Potassium oxide,	.046
Phosphoric acid,	.041
Calcium oxide,	.045

7. Miscellaneous Fodder Analyses.

[I., corn ensilage, sent on from Marlborough, Mass.; II., oat and pea ensilage, sent on from Marlborough, Mass.; III., corn ensilage, sent on from Amherst, Mass.; IV., ensilage of *Panicum miliaceum*, sent on from Amherst, Mass.; V., ensilage of *Panicum crus-galli*, sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	79.98	38.02	71.27	78.01	76.75
Dry matter,	20.02	61.98	28.73	21.99	23.25
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	5.50	9.19	6.05	8.32	8.57
" cellulose,	25.24	31.34	22.89	31.80	36.93
" fat,	3.20	3.94	4.86	3.34	2.74
" protein,	8.22	13.72	10.00	7.46	7.89
Nitrogen-free extract matter,	57.84	41.81	56.20	49.08	43.87
	100.00	100.00	100.00	100.00	100.00

[I., millet (*Panicum crus-galli*), sent on from Amherst, Mass.; II., soja bean (late), sent on from Amherst, Mass.; III., soja bean (early green), sent on from Amherst, Mass.; IV., soja bean (early white), sent on from Amherst, Mass.; V., soja bean (medium black), sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV	V.
Moisture at 100° C.,	75.11	79.78	69.84	66.56	76.87
Dry matter,	24.89	20.22	30.16	33.44	23.13
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	9.75	21.33	12.97	15.25	12.66
" cellulose,	29.51	23.62	23.51	27.12	21.73
" fat,	2.79	2.25	3.87	2.77	6.76
" protein,	11.45	18.56	19.35	17.63	21.67
Nitrogen-free extract matter,	46.50	34.24	40.40	37.23	37.18
	100.00	100.00	100.00	100.00	100.00

7. Miscellaneous Fodder Analyses — *Continued.*

[I., soja-bean straw, sent on from Amherst, Mass.; II., Japanese radish (*merinia*), sent on from Amherst, Mass.; III., Japanese radish (*niyashige*), sent on from Amherst, Mass.; IV., soja-bean meal, sent on from Amherst, Mass.; V., cotton-seed hulls, sent on from Boston, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . .	13.97	93.26	92.58	10.80	8.15
Dry matter, ...	86.03	6.74	6.74	89.20	91.85
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash, ...	5.57	10.32	9.87	5.04	2.81
" cellulose, . . .	46.51	10.27	9.79	5.01	46.60
" fat, ...	1.17	1.05	.96	18.17	1.79
" protein, . . .	5.73	7.47	6.51	41.18	4.10
Nitrogen-free extract matter, .	41.02	70.89	72.87	30.60	44.70
	100.00	100.00	100.00	100.00	100.00

[I., ground oats, sent on from Baldwinville, Mass.; II., wheat bran, sent on from Amherst, Mass.; III., dried brewers' grain, sent on from Boston, Mass.; IV., new-process linseed meal, sent on from North Amherst, Mass.; V., cotton-seed meal, sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., . .	9.71	9.85	7.99	10.19	6.48
Dry matter, ...	90.29	90.15	92.01	89.81	93.52
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash, ...	3.93	7.11	–*	–*	7.16
" cellulose, . . .	9.29	11.82	–*	–*	5.60
" fat, ...	3.51	5.30	6.04	2.89	11.04
" protein, ...	13.20	18.17	18.74	38.84	46.08
Nitrogen-free extract matter, .	70.07	57.60	–*	–*	30.12
	100.00	100.00	–	–	100.00

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., Richardson glucose feed, sent on from Amherst, Mass.; II., glucose refuse, sent on from Boston, Mass.; III., starch feed (Pope), sent on from Amherst, Mass.; IV., rye feed, sent on from North Dartmouth, Mass.; V., oat feed, sent on from Baldwinville, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.32	6.71	5.48	9.63	9.47
Dry matter,	93.68	93.29	94.52	90.37	90.53
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	1.13	1.20	.90	2.62	3.98
" cellulose,	5.00	4.77	15.21	3.52	8.06
" fat,	11.67	10.55	11.30	2.79	4.28
" protein,	23.12	21.06	11.28	13.56	15.60
Nitrogen-free extract matter,	59.08	62.42	61.31	77.51	69.08
	100.00	100.00	100.00	100.00	100.00

[I., proteina, sent on from North Amherst, Mass.; II., proteina, sent on from Weston, Mass.; III., proteina, sent on from Bolton, Mass.; IV., cooked feed (oats and corn), sent on from Worcester, Mass.; V., excelsior feed, sent on from Holden, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	8.04	6.80	8.63	5.55	7.08
Dry matter,	91.96	93.20	91.31	94.45	92.92
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	2.80	3.24	2.13	4.04	4.43
" cellulose,	12.33	10.18	–*	8.73	14.65
" fat,	7.74	8.24	8.53	5.34	5.42
" protein,	24.47	27.23	24.57	14.75	9.75
Nitrogen-free extract matter,	52.66	51.11	–*	67.14	65.75
	100.00	100.00	–	100.00	100.00

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., gluten feed (Pope), sent on from Amherst, Mass.; II., gluten feed, sent on from Marlborough, Mass.; III. and IV., gluten feed, sent on from Amherst, Mass.; V., gluten feed, sent on from Sunderland, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	13.98	7.64	8.06	8.99	9.39
Dry matter,	86.02	92.36	91.94	91.01	90 61
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	.75	1.14	–*	–*	–*
" cellulose,	1.80	5.78	–*	–*	–*
" fat,	16.34	9.18	7.57	7.71	13.71
" protein,	38.68	21.11	27.19	27.33	27.45
Nitrogen-free extract matter,	42.43	62.79	–*	–*	–*
	100.00	100.00	–	–	–

[I., gluten meal, sent on from North Amherst, Mass.; II., gluten meal, sent on from Agawam, Mass.; III., gluten meal, sent on from Sunderland, Mass.; IV., gluten meal, sent on from South Acton, Mass.; V., gluten meal, sent on from Boston, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	6.93	5.93	6.85	7.29	6.15
Dry matter,	93.07	94.07	93.15	92.71	93.85
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	.69	.50	–*	–*	–*
" cellulose,	9.08	5.80	–*	–*	–*
" fat,	9.81	12.08	10.67	7.07	16.52
" protein.	14.51	30.63	25.43	32.56	29.47
Nitrogen-free extract matter,	65.91	50.99	–*	–*	–*
	100.00	100.00	–	–	–

* Not determined.

7. Miscellaneous Fodder Analyses — *Concluded.*

[I., pea bran, sent on from Great Barrington, Mass.; II., Louisiana rice bran, sent on from Sudbury, Mass.; III., bran, sent on from South Acton, Mass.; IV., oat meal and barley refuse, sent on from Amherst, Mass.; V., cranberries, sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.14	10.25	6.67	7.76	89.41
Dry matter,	92.86	89.75	93.33	92.24	10.59
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	3.33	10.59	–*	3.84	1.99
" cellulose,	46.16	14.86	–*	22.30	11.63
" fat,	1.16	9.66	5.04	3.80	5.61
" protein,	10.31	9.82	17.88	7.45	4.40
Nitrogen-free extract matter,	39.04	55.07	–*	62.61	76.37
	100.00	100.00	–	100.00	100.00

* Not determined.

II.

Analyses of Milk sent on for Examination.

[Per Cent.]

Number of Sample.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1, . .	11.77	3.03	8.74	Westborough.	
2, . .	12.29	3.37	8.92	Westborough.	
3, . .	12.83	3.61	9.22	Marblehead.	
4, . .	13.19	3.93	9.26	Marblehead.	
5, . .	12.24	3.38	8.86	Berlin.	
6, . .	13.30	4.62	8.68	Barre.	
7, . .	11.71	3.36	8.35	Furnace.	
8, . .	10.34	3.11	7.23	Northampton.	
9, . .	12.98	3.90	9.08	Barre Plains.	
10, . .	12.78	3.80	8.98	Barre Plains.	
11, . .	10.53	1.28	9.25	Barre Plains.	
12, . .	14.11	5.07	9.04	Barre Plains.	
13, . .	4.62	.28	3.43	Amherst.	Whey.
14, . .	6.32	–	–	Adams.	Whey.
15, . .	12.60	3.36	9.24	Westborough.	
16, . .	12.70	3.50	9.20	Gilbertville.	
17, . .	12.53	4.02	8.51	Furnace.	
18, . .	13.29	4.27	9.03	Barre Plains.	
19, . .	12.06	3.21	8.85	Granby.	
20, . .	9.24	.30	8.94	Granby.	Skim-milk
21, . .	12.50	3.81	8.69	Gilbertville.	
22, . .	13.07	4.31	8.76	Barre.	
23, . .	13.43	4.48	8.95	Barre Plains.	
24, . .	12.66	3.81	8.85	New Braintree.	
25, . .	11.68	1.80	9.80	Westborough.	
26, . .	11.76	2.05	9.71	Westborough.	

III.

Analyses of Water sent on for Examination.*

[Parts per million.]

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
1	.012	.140	2.00	108.00	50.00	1.11	-	Barre.
2	.052	.128	26.00	112.00	72.00	2.08	-	North Amherst.
3	.012	.072	3.00	88.00	56.00	-	-	Barre.
4	.248	.220	4.00	192.00	92.00	3.38	-	East Amherst.
5	.028	.084	6.00	104.00	48.00	3.25	-	Amherst.
6	.088	.144	4.00	170.00	82.00	2.34	None.	Littleton.
7	.008	.140	7.00	70.00	36.00	.79	-	Prescott.
8	.016	.092	6.00	116.00	60.00	2.34	None.	Littleton.
9	.012	.152	4.00	112.00	44.00	.63	None.	Littleton.
10	.052	.360	18.00	180.00	60.00	2.60	-	Upton.
11	.080	.160	8.00	100.00	40.00	2.08	-	Leverett.
12	.076	.316	15.00	330.00	130.00	6.86	-	Westminster.
13	Trace.	.340	15.00	740.00	316.00	46.60	-	Weston.
14	.012	.104	8.00	120.00	40.00	1.95	-	Weston.
15	.020	.180	14.00	120.00	36.00	2.73	-	Nichawong.
16	.048	.084	25.00	220.00	56.00	5.29	-	Globe Village.
17	1.660	.760	43.00	366.00	126.00	7.43	-	Globe Village.
18	.016	.080	34.00	310.00	100.00	6.43	-	Globe Village.
19	.028	.080	14.00	126.00	46.00	4.03	-	Framingham.
20	Trace.	.104	10.00	238.00	74.00	5.71	None.	Amherst.
21	.028	.092	6.00	120.00	56.00	4.57	-	Plainfield.
22	.184	.336	16.00	200.00	84.00	5.86	-	East Templeton.
23	.660	.268	34.00	310.00	70.00	10.75	-	Templeton.
24	.136	.192	76.00	220.00	100.00	11.50	-	Charlton Depot.
25	Trace.	.116	2.00	128.00	50.00	1.56	-	Chatham.
26	.568	.152	40.00	286.00	130.00	10.60	-	Amherst.

* Analysis of well water at the station is confined to chemical tests with reference to an excess of foreign matter from sinks, barns, etc.

Analyses of Water, etc. — *Continued.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat	Hardness (Clark's Degree).	Lead.	Locality.
27	.776	.172	40.00	300.00	60.00	8.86	-	Concord.
28	.300	.240	224.00	956.00	200.00	10.90	-	Concord.
29	.160	.240	10.00	200.00	60.00	1.56	-	Concord.
30	.056	.108	6.00	-	-	1.43	-	Amherst.
31	.072	.100	26.00	220.00	100.00	5.43	-	Amherst.
32	.672	.308	98.00	640.00	200.00	9.43	-	Amherst.
33	.044	.096	50.00	360.00	100.00	10.00	-	Concord.
34	.116	.168	66.00	340.00	90.00	10.75	-	Concord.
35	.064	.248	36.00	240.00	80.00	4.71	-	Concord.
36	.100	.184	36.00	410.00	130.00	7.43	-	Concord.
37	.024	.176	12.00	140.00	56.00	4.29	-	South Acton.
38	Trace.	.092	8.00	256.00	80.00	7.43	None.	South Acton.
39	.240	.180	8.00	230.00	90.00	4.03	-	South Amherst.
40	None.	.060	4.00	200.00	52.00	4.29	-	Oakdale.
41	.040	.064	20.00	200.00	40.00	1.95	-	Amherst.
42	None.	.292	3.00	104.00	40.00	1.95	-	South Deerfield.
43	.020	.140	20.00	160.00	64.00	2.73	-	Concord.
44	.040	.124	6.00	120.00	72.00	1.95	-	Concord.
45	.052	.128	42.00	260.00	100.00	5.71	-	Concord.
46	.044	.136	15.00	160.00	92.00	2.21	-	Concord.
47	Trace.	.160	22.00	240.00	100.00	4.86	-	Barre.
48	.082	.324	20.00	286.00	58.00	4.86	-	Amherst.
49	.024	.186	17.00	250.00	80.00	4.43	-	Amherst.
50	.032	.086	13.00	140.00	28.00	1.69	-	Concord.
51	.372	.100	7.00	144.00	86.00	.48	-	North Andover.
52	.344	.326	8.00	128.00	52.00	1.11	-	North Andover.
53	.080	.184	15.00	236.00	100.00	4.03	-	Shirley.
54	.036	.266	4.00	96.00	54.00	-	-	Amherst.
55	.022	.256	-	62.00	36.00	-	-	Amherst.
56	.078	.160	6.00	64.00	14.00	-	-	Amherst.
57	.028	.120	24.00	224.00	120.00	5.14	-	Amherst
58	.100	.104	10.00	140.00	64.00	3.51	-	Westfield.
59	.028	.150	3.00	124.00	64.00	2.86	-	South Deerfield.
60	.016	.092	10.00	100.00	32.00	1.82	-	Weston.
61	.060	.132	11.00	112.00	44.00	2.60	-	Weston.

ANALYSES OF WATER, ETC. — *Concluded.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at Red Heat.	Hardness (Clark's Degree).	Lead.	Locality.
62	.094	.190	22.00	236.00	140.00	4.71	–	Barre.
63	.072	.164	8.00	200.00	52.00	2.47	–	Wellesley Hills.
64	.204	.244	4.00	132.00	48.00	1.11	–	Petersham.
65	.052	.120	7.00	110.00	32.00	2.08	–	Chelmsford.
66	.032	.244	3.00	160.00	90.00	.79	–	North Brookfield.
67	.032	.084	14.00	152.00	42.00	1.95	None.	North Amherst.
68	3.200	1.300	35.00	260.00	44.00	6.00	–	South Deerfield.
69	Trace.	.136	6.00	84.00	28.00	1.95	–	Leverett.
70	.132	.100	6.00	96.00	56.00	.32	–	South Sudbury.
71	.084	.148	4.00	116.00	24.00	–	–	South Deerfield.
72	2.560	1.456	5.00	112.00	16.00	1.11	–	South Deerfield.
73	.016	.076	2.00	76.00	24.00	2.08	–	Concord.
74	.020	.096	4.00	60.00	24.00	.16	–	Amherst.
75	.272	.296	4.00	136.00	96.00	1.69	–	Littleton.
76	.040	.144	18.00	160.00	72.00	1.69	–	Littleton.
77	.272	.208	7.00	176.00	92.00	3.25	–	Littleton.
78	.040	.088	8.00	120.00	36.00	2.60	–	Littleton.
79	.036	.068	24.00	240.00	140.00	5.43	–	Littleton.
80	.240	.200	4.00	260.00	120.00	6.86	–	Littleton.
81	2.400	1.300	33.00	276.00	52.00	6.57	–	South Deerfield.
82	.032	.152	2.00	100.00	36.00	2.60	–	Holyoke.
83	.044	.068	2.00	104.00	40.00	4.86	–	Holyoke.
84	.036	.172	2.00	76.00	32.00	2.21	–	Holyoke.
85	.088	.096	3.00	164.00	20.00	7.43	–	Holyoke.
86	.020	.084	6.00	168.00	32.00	5.86	–	Framingham.
87	.012	.108	3.00	136.00	72.00	3.38	–	Chelmsford.
88	.028	.096	20.00	184.00	44.00	2.99	–	Westminster.
89	.020	.084	7.00	220.00	108.00	3.25	–	Littleton.
90	Trace.	.076	8.00	140.00	40.00	3.51	–	Littleton.
91	.064	.072	10.00	776.00	100.00	4.86	–	Framingham.
92	.020	.076	8.00	112.00	52.00	2.47	–	Westminster.
93	.040	.068	2.00	96.00	56.00	1.11	–	Westminster.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the

indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wanklyn and E. T. Chapman.)

Mr. Wanklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon* of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

An examination of the previously stated analyses indicates that Nos. 4, 10, 11, 12, 13, 15, 17, 22, 23, 24, 26, 27, 28, 29, 32, 34, 35, 36, 37, 39, 42, 48, 49, 51, 52, 53, 54, 55, 56, 62, 63, 64, 66, 68, 72, 75, 77, 80, 81, 82 and 84 ought to be condemned as unfit for family use; while Nos. 1, 2, 6, 7, 9, 31, 47, 58, 59, 61, 65, 69, 70, 71, 76 and 85 must be considered suspicious. From this record it will be seen that one-half of the entire number of well waters tried proved unfit for drinking. Heating waters to the boiling point not unfrequently removes immediate danger.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One gallon is desirable for the analysis.

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* One gallon equals 70,000 grains.

IV. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

Prepared by C. S. Crocker.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1894.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1893, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	66	1.98	–	–	–	–	58.98	45.94	**51.05**	–	–	–	–	–	–	6.69	–	.55	–	–	–	48.80	.70
Sulphate of potash,	24	2.55	–	–	–	–	51.28	21.36	**34.99**	–	–	–	–	–	–	4.46	–	1.50	–	45.72	–	–	.75
Sulphate of potash magnesia,	16	4.96	–	–	–	–	29.48	16.96	**23.55**	–	–	–	–	–	–	6.25	2.57	–	–	44.25	–	2.60	1.41
Carbonate of potash,	1	26.88	–	–	–	–	–	–	**18.48**	–	–	–	–	–	–	–	–	19.52	–	–	–	–	.39
Phosphate of potash,	1	3.76	–	–	–	–	–	–	**32.56**	–	–	**37.50**	–	–	–	–	–	–	–	13.43	–	–	.92
Kainite,	4	3.20	–	–	–	–	16.48	12.51	**13.54**	–	–	–	–	–	–	18.97	1.15	9.80	–	20.25	–	33.25	2.13
Carnallite,	1	–	–	–	–	–	–	–	**13.68**	–	–	–	–	–	–	7.66	–	13.19	–	.56	–	41.56	–
Krugite,	1	4.82	–	–	–	–	–	–	**8.42**	–	–	–	–	–	–	5.27	12.45	8.79	–	31.94	–	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.82	17.30	–	36.10	–	–	5.73
Nitrate of potash,	4	1.30	–	14.58	11.60	**12.71**	45.62	44.76	**45.27**	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nitrate of soda,	25	1.47	–	16.01	14.28	**14.70**	–	–	–	–	–	–	–	–	–	35.50	–	–	–	–	–	.50	.50
Sulphate of ammonia,	26	1.05	–	21.68	19.59	**22.16**	–	–	–	–	–	–	–	–	–	–	–	–	–	60.00	–	–	–
Phosphate of ammonia,	1	6.05	–	–	–	**10.37**	–	–	–	–	–	**43.86**	–	–	–	–	–	–	–	12.46	–	–	.82
Sulphate of soda,	1	1.38	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	59.43	–	–	–
Saltpetre waste,	12	2.54	–	3.30	.52	**2.22**	30.94	1.55	**13.66**	–	–	–	–	–	–	37.04	.75	.19	–	1.85	–	46.25	–

Nitre salt-cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Wood ashes,	329	12.75	-	-	-	-	10.80	2.32	5.33	5.58	.05	1.59	-	-	-	-	33.73	3.31	.96	-	-	-	14.12
Cotton-seed-hull ashes,	40	8.15	-	-	-	-	42.12	9.91	22.48	13.67	2.89	8.40	-	-	-	-	9.33	10.47	1.71	-	-	-	13.32
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	2	1.10	-	-	-	-	.08	-	.04	.70	.11	.40	-	-	-	-	31.09	1.46	1.46	-	32.95	-	3.09
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Swill ashes,	4	.18	-	-	-	-	8.83	1.25	4.71	32.36	16.61	23.06	-	-	-	-	33.58	1.87	4.65	-	-	-	17.74
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypsum,	3	13.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.86	-	-	48.01	-	-	.59
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster,	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.85	.75	-	45.75	-	-	2.50
Onondaga plaster,	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	96.10	-	-	-	-	-	1.33
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes,	11	15.90	-	-	-	-	2.12	.02	1.15	3.16	.36	1.02	-	-	-	-	42.17	2.60	-	-	17.75	-	7.87
Marls (Massachusetts),	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44

				Nitrogen.			Potash.			Total Phosphoric Acid.													
	Analyses.	Moisture.	Ash.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. —Concluded.																							
Marls (Virginia), ...	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Greens and marl (Virginia), ...	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia), ...	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl, ...	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina), ...	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called), ...	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano, ...	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas, ...	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida, ...	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida, ...	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15
Cuba guano, ...	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla), ...	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Mona Island guano, ...	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45

South Carolina rock phosphate,	6	1.45	-	-	-	-	-	-	-	30.51	24.70	27.47	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	27	2.07	-	-	-	-	-	-	-	38.97	6.95	26.78	-	-	-	-	30.32	-	7.59	-	-	-	27.49
Soft Florida phosphate,	1	2.24	-	-	-	-	-	-	-	-	-	17.71	-	-	-	-	14.64	-	6.72	-	-	-	13.37
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	3	3.35	-	-	-	-	.52	.32	.42	19.45	18.40	18.75	-	-	-	-	52.85	-	-	-	2.51	-	5.90
Dissolved bone-black,	4	11.14	47.50	-	-	-	-	-	-	17.54	15.35	16.04	14.56	1.12	.36	-	-	-	-	-	-	-	3.46
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	16	12.23	6.37	13.55	8.10	10.51	-	-	-	6.23	1.53	2.05	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Continued.																							
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	–	–	–	2.30	1.36	1.83	–	–	–	–	–	–	–	–	–	–	.24
Raw wool,	1	6.95	7.54	–	–	12.88	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.63
Wool waste,	8	14.26	24.10	10.20	1.05	5.27	3.08	.06	1.21	.67	.05	.35	–	–	–	–	.11	.06	.80	–	–	–	8.20
Wool washings (water),	1	–	–	–	–	–	–	–	3.92	–	–	–	–	–	–	.49	.28	–	–	–	–	–	–
Wool washings (acid),	1	–	–	–	–	–	–	–	4.20	–	–	–	–	–	–	.40	.61	.20	–	–	–	–	–
Wool washings (alkaline),	1	92.03	3.28	–	–	.09	–	–	1.09	–	–	–	–	–	–	.92	.04	–	–	–	–	–	.22
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	–	–	–	3.58	.56	2.07	–	–	–	–	–	–	–	–	–	–	.58
Bone soup,	1	82.92	7.07	–	–	1.14	–	–	–	–	–	1.26	–	–	–	–	–	–	–	–	–	–	–
Dried soup from meat and bone,	1	14.80	8.40	–	–	9.97	–	–	–	–	–	.53	–	–	–	–	–	–	–	–	–	–	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	–	–	14.47	–	–	–	–	–	.46	–	–	–	–	–	–	–	–	–	–	.26
Dried soup from horse rendering,	1	92.14	–	–	–	1.12	–	–	–	–	–	.14	–	–	–	–	–	–	–	–	–	–	–
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	–	–	–	15.37	11.04	13.21	–	–	–	–	–	–	–	–	–	–	1.29
Bones,	148	6.94	56.03	4.70	1.57	3.96	–	–	–	32.52	15.16	22.24	.38	8.24	13.62	–	–	–	–	–	–	–	1.09
Meat and bone,	1	5.70	–	–	–	4.01	–	–	–	–	–	21.88	.26	8.32	13.30	–	–	–	–	–	–	–	–
Fish with less than twenty per cent. water,	62	12.56	21.50	11.40	6.81	7.32	–	–	–	11.26	5.50	8.25	.55	2.64	5.06	–	–	–	–	–	–	–	2.01

Fish with between twenty and forty per cent. water,	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	24	6.47	5.78	7.26	4.02	6.63	2.09	.48	1.69	3.36	.73	1.54	-	-	-	-	-	-	-	-	-	-	.33
Rotten brewers' grain,	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	6	10.61	14.07	2.91	.90	2.29	8.82	3.76	6.44	2.09	.44	.60	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	3	6.44	60.60	2.09	.96	1.50	1.62	.66	1.10	.84	.26	.52	-	-	-	-	-	-	-	-	-	-	45.00
Cotton dust,	1	34.46	50.93	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.																							
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-	-	1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60
Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	16	60.26	13.75	2.54	.26	.97	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	11.35
Peat,	10	61.50	8.20	1.40	.41	.85	-	-	.18	-	-	.08	-	-	-	-	.52	.72	2.14	-	-	-	2.20
Peat,	1	10.73	17.26	-	-	1.73	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Soot,	3	1.88	77.10	.21	.09	.15	1.83	.21	.76	1.54	.19	.87	-	-	-	-	3.11	-	7.19	-	-	-	67.25
Boiler soot,	1	18.80	-	-	-	-	-	-	.26	-	-	.70	-	-	-	-	58.28	1.46	1.46	-	32.95	-	3.09
IV. Animal Excrement, etc.																							
Barn-yard manure,	56	66.49	-	1.366	.21	.54	1.40	.13	.53	.75	.10	.41	-	-	-	-	.30	.19	-	-	-	-	8.48
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.46	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	1	64.88	-	-	-	.686	-	-	.525	-	-	.425	-	-	-	-	-	-	-	-	-	-	.404
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Hen manure, fre ,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen manure, dry,	1	8.35	-	-	-	2.13	-	-	9.94	-	-	2.02	-	-	-	-	2.22	.62	-	-	-	-	34.64

V. Compilation of Analyses of Fodder Articles, Fruits, Sugar-producing Plants, Dairy Products, etc.,

MADE AT

AMHERST, MASS.

1868-1894.

Prepared by C. S. Crocker.

A. Analyses of Fodder Articles.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

C. Analyses of Fruit.

D. Analyses of Sugar-producing Plants.

E. Dairy Products.

F. Insecticides.

A. *Analyses of Fodder Articles.*

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
I. Green Fodders.																	
Fodder corn,	31	31.47	10.33	20.29	17.19	6.05	9.86	6.10	1.42	2.44	63.13	42.02	56.51	31.53	18.27	25.29	5.90
Fodder corn ensilage,	38	37.43	13.12	21.70	16.72	5.98	8.66	6.49	1.82	3.80	65.69	42.99	54.28	38.92	17.67	27.73	5.53
Corn and soja-bean ensilage,	3	28.97	19.67	23.55	15.27	7.91	10.53	5.35	3.02	4.04	52.24	40.50	43.47	37.84	26 62	31.15	10.81
Oat and pea ensilage,	1	–	–	61.98	–	–	13.72	–	–	3.94	–	–	41.81	–	–	31.34	9.19
Ensilage of *Panicum miliaceum*,	1	–	–	21.99	–	–	7.46	–	–	3.34	–	–	49.08	–	–	31.80	8.32
Ensilage of *Panicum crus-galli*,	1	–	–	23.25	–	–	7.89	–	–	2.74	–	–	43.87	–	–	36.93	8.57
Sorghum,	6	23.18	12.38	17.41	11.84	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83
Common millet,	9	42.29	21.32	35.42	12.16	5.43	7.50	3.99	2.09	2.74	58.61	46.39	53.93	33.98	24.88	30.99	4.84
Japanese millet (white head),	3	26.24	20.95	24.76	10.98	7.26	8.72	2.64	1.94	2.33	50.87	46.71	49.60	38.90	30.12	34.47	4.88
Japanese millet (red head),	6	33.83	22.66	27.33	7.99	4.92	6.90	2.45	1.58	2.01	60.83	50.11	52.91	35.29	25.21	32.10	6.08
Panicum miliaceum,	1	–	–	30.63	–	–	5.96	–	–	3.84	–	–	58.82	–	–	26.85	5.53
Panicum crus-galli,	2	29.28	24.89	27.08	11.45	7.98	9.71	2.79	2.20	2.49	57.88	46.50	52.20	29.51	26.31	27.91	7.69
White kibi,	2	24.26	22.85	23.56	15.14	10.79	12.97	1.61	1.50	1.56	53.66	52.30	47.29	35.29	25.21	32.10	6.08
Mochi millet,	3	42.29	30.07	37.42	11.90	6.11	9.94	1.94	1.74	1.81	67.08	49.06	55.69	29.80	20.01	25.56	7.00
Green oats,	6	55.69	15.51	25.97	20.47	7.05	13.91	3.95	2.02	2.89	50.69	40.42	44.91	33.12	25.20	30.04	8.25
Green rye,	2	37.89	98.05	27.97	9.64	5.38	7.51	2.46	1.86	2.16	65.37	40.20	52.79	42.17	21.52	31.84	5.70

Green barley,	1	-	-	20.89	-	-	13.16	-	-	2.91	-	-	37.48	-	-	37.72	8.73
Timothy (*Phleum pratense*),	2	35.00	34.26	34.63	8.83	8.20	8.52	2.07	1.95	2.01	51.33	51.23	51.27	33.23	32.50	32.87	5.33
Hungarian grass (*Setaria Italica* Beauv.),	2	25.93	25.69	25.81	9.39	9.38	9.38	2.43	1.01	1.72	57.80	48.01	52.92	31.23	24.66	27.94	8.04
Vetch and oats (one part vetch and four parts oats),	1	-	-	20.84	-	-	13.27	-	-	3.90	-	-	43.69	-	-	30.34	8.80
Vetch and oats (one part vetch and nine parts oats),	3	24.04	13.89	18.97	10.76	8.83	10.06	2.74	2.29	2.53	49.85	40.10	44.75	35.81	30.77	33.59	9.07
Vetch and oats (equal parts of each),	1	-	-	17.98	-	-	16.77	-	-	2.79	-	-	41.33	-	-	29.80	9.31
Barley and peas,	1	-	-	16.09	-	-	13.40	-	-	3.00	-	-	41.79	-	-	33.49	8.32
Oats and peas,	2	18.41	13.68	16.04	16.01	14.17	15.09	3.40	2.29	2.84	48.14	40.56	44.36	32.20	26.66	29.43	8.28
Horse bean (*Vicia faba*, L.),	1	-	-	15.17	-	-	16.68	-	-	2.31	-	-	47.09	-	-	28.17	5.75
Flat pea (*Lathyrus sylvestris*),	1	-	-	21.38	-	-	30.65	-	-	5.00	-	-	35.06	-	-	20.38	8.91
Soja bean (*Soja hispida*),	14	36.36	18.54	24.48	22.19	13.71	17.26	8.98	2.71	4.57	47.89	34.24	41.73	31.89	21.67	26.47	9.97
Soja bean (early white),	1	-	-	33.44	-	-	17.63	-	-	2.77	-	-	37.23	-	-	27.12	15.25
Soja bean (early green),	1	-	-	30.16	-	-	19.35	-	-	3.87	-	-	40.30	-	-	23.51	12.97
Soja bean (medium black),	1	-	-	23.13	-	-	21.67	-	-	6.76	-	-	37.18	-	-	21.73	12.66
Soja bean (late),	1	-	-	20.22	-	-	18.56	-	-	2.25	-	-	34.24	-	-	23.62	21.33
Kidney vetch (*Anthyllis vulneraria*),	1	-	-	19.15	-	-	18.43	-	-	3.51	-	-	49.84	-	-	14.94	13.28
Cow-pea vines (*Dolichos sinensis*),	3	21.19	18.15	19.63	17.93	11.24	14.59	2.99	1.81	2.48	60.62	46.13	54.42	25.88	21.87	23.59	6.92
Serradella (*Ornithopus sativus* Brot.),	3	19.42	15.40	17.59	17.75	12.17	15.01	2.65	2.09	2.41	46.41	35.45	41.51	38.76	26.21	30.08	10.99
Prickley comfrey (*Symphytum officinale*),	1	-	-	13.21	-	-	17.49	-	-	2.06	-	-	48.30	-	-	11.03	21.12
White lupine (*Lupinus albus*),	1	-	-	14.65	-	-	18.71	-	-	2.41	-	-	42.67	-	-	31.18	5.03
Yellow lupine (*Lupinus luteus*),	1	-	-	13.95	-	-	17.84	-	-	1.87	-	-	42.05	-	-	27.10	11.14
Spanish moss (*Tillandsia usneoides*),	1	-	-	39.20	-	-	4.45	-	-	2.54	-	-	57.73	-	-	32.61	2.67

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
II. Hay and Dry Coarse Fodders.																	
English hay (mixed hay),	56	91.94	66.59	**85.53**	14.19	6.19	**9.46**	4.10	1.56	**2.85**	54.72	43.63	**50.29**	35.55	26.41	**31.05**	6.35
Rowen of mixed hays,	14	91.76	75.55	**82.83**	14.70	11.63	**12.60**	5.03	2.60	**3.64**	53.52	41.92	**49.76**	31.50	24.25	**26.82**	7.18
Timothy hay,	6	92.76	81.26	**89.39**	9.37	7.24	**8.66**	2.65	1.95	**2.22**	54.43	50.01	**51.34**	36.59	29.21	**32.90**	4.88
Red top hay (*Agrostis vulgaris* With.),	4	93.19	91.76	**92.30**	8.40	6.41	**7.88**	1.69	1.50	**1.60**	54.74	50.32	**52.63**	34.11	31.12	**32.92**	4.97
Kentucky blue-grass (*Poa pratensis* L.),	2	96.10	93.22	**94.66**	8.78	8.65	**8.72**	2.08	2.03	**2.06**	49.61	44.11	**46.29**	36.84	32.21	**34.58**	8.35
Orchard grass (*Dactylis glomerata* L.),	4	91.62	90.86	**91.17**	11.29	7.57	**8.99**	3.56	2.40	**2.91**	47.34	43.50	**46.16**	35.79	34.12	**34.89**	7.05
Meadow fescue (*Festuca pratensis* Huds.),	5	94.70	87.84	**91.09**	7.85	5.89	**6.76**	2.17	1.65	**1.87**	49.18	42.03	**46.31**	39.90	34.61	**36.93**	8.13
Perennial rye-grass (*Lolium perenne* L.),	4	93.64	90.50	**92.60**	16.56	6.59	**11.71**	3.15	1.59	**2.37**	55.77	38.82	**48.14**	30.86	26.79	**29.64**	8.14
Italian rye grass (*Lolium Italicum* A. Br.),	4	92.62	90.70	**91.54**	9.75	6.20	**8.15**	2.07	1.39	**1.85**	52.80	43.09	**49.14**	36.90	31.27	**33.34**	7.52
Hungarian grass,	1	–	–	**92.55**	–	–	**9.45**	–	–	**2.22**	–	–	**50.64**	–	–	**31.96**	5.73
Barn-yard grass (*Panicum crus-galli* L.),	1	–	–	**93.35**	–	–	**15.27**	–	–	**1.95**	–	–	**30.24**	–	–	**33.72**	10.02
Hay of black grass,	1	–	–	**91.25**	–	–	**6.72**	–	–	**3.37**	–	–	**49.47**	–	–	**31.41**	9.03
Low meadow hay,	1	–	–	**91.99**	–	–	**9.51**	–	–	**1.88**	–	–	**46.27**	–	–	**35.59**	6.75
Salt hay,	2	91.92	90.34	**91.13**	4.35	3.77	**4.06**	3.24	2.65	**2.95**	60.15	60.14	**60.14**	27.84	27.82	**27.83**	5.02
Millet,	6	93.85	90.25	**92.54**	8.88	7.09	**7.81**	3.63	.89	**2.05**	55.80	49.62	**51.74**	35.91	29.80	**33.32**	5.08
Oats in bloom,	1	–	–	**93.57**	–	–	**6.58**	–	–	**2.92**	–	–	**50.03**	–	–	**34.06**	6.41

Oats in milk,	1	-	-	90.45	-	-	10.89	-	-	2.69	-	-	46.02	-	-	34.32	6.08
Oats, ripe,	1	-	-	91.30	-	-	6.05	-	-	2.61	-	-	48.92	-	-	36.31	6.11
Winter rye in bloom,	1	-	-	91.45	-	-	10.66	-	-	2.57	-	-	47.40	-	-	32.97	6.40
Barley in milk,	1	-	-	89.75	-	-	10.26	-	-	2.76	-	-	52.91	-	-	29.12	4.95
Common buckwheat,	1	-	-	91.50	-	-	17.90	-	-	3.04	-	-	45.08	-	-	13.35	14.63
Silver-hull buckwheat,	1	-	-	91.09	-	-	12.22	-	-	2.55	-	-	47.99	-	-	27.07	10.17
Japanese buckwheat,	1	-	-	94.29	-	-	10.80	-	-	2.22	-	-	38.60	-	-	36.02	12.36
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	33.75	23.03	29.31	5.14
Corn stover,	27	94.44	75.00	88.15	12.15	5.46	7.28	2.63	1.08	1.38	63.05	44.65	50.60	38.83	20.93	34.95	5.79
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	-	-	93.94	-	-	9.71	-	-	1.28	-	-	53.18	-	-	28.88	6.95
Mammoth red clover (*Trifolium medium* L.),	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11
Sand lucerne (*Medicago media* Pers.),	1	-	-	91.20	-	-	16.26	-	-	2.59	-	-	50.31	-	-	21.27	9.57
Bokhara clover (*Melilotus alba* Desr.)	2	93.64	91.50	92.57	14.93	11.81	13.37	4.79	1.85	3.32	51.36	38.83	45.08	33.05	28.08	30.57	7.66
Blue melilot (*Melilotus cœrulea* Desr.),	1	-	-	91.78	-	-	13.81	-	-	1.67	-	-	42.48	-	-	27.17	14.87
Sanfoin (*Onobrychis sativa*),	1	-	-	87.83	-	-	17.70	-	-	4.49	-	-	42.32	-	-	26.95	8.54
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32
Hairy lotus (*Lotus villosus* Thuill.),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27
Summer rape (*Brassica napus*),	1	-	-	88.87	-	-	14.43	-	-	3.79	-	-	45.38	-	-	18.15	18.25
Soja bean,	4	93.88	79.91	87.78	19.06	14.89	16.23	8.33	2.55	4.72	51.28	41.09	46.70	27.73	20.76	24.02	8.33

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
II. Hay and Dry Coarse Fodders — Concluded.																	
Cow-pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29
Small pea (*Lathyrus sativus*),	1	–	–	94.20	–	–	16.57	–	–	1.49	–	–	42.76	–	–	32.88	6.30
Flat pea (*Lathyrus sylvestris*),	1	–	–	91.10	–	–	24.04	–	–	1.78	–	–	33.03	–	–	31.76	9.39
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.22	44.49	48.18	25.92	24.37	25.15	7.09
Hairy vetch (*Vicia villosa* Roth.),	1	–	–	92.56	–	–	19.58	–	–	1.22	–	–	38.95	–	–	31.88	8.37
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24
Scotch tares,	1	–	–	84.20	–	–	22.00	–	–	1.89	–	–	31.46	–	–	30.89	13.76
Vetch and oats,	3	94.22	83.33	88.35	13.51	7.70	9.64	3.45	2.53	3.11	49.95	41.51	46.83	36.22	30.15	32.70	7.72
Horse-bean straw,	1	–	–	90.85	–	–	9.69	–	–	1.51	–	–	37.77	–	–	41.44	9.59
Soja-bean straw,	3	92.37	86.03	88.57	5.73	5.34	5.48	3.49	1.17	2.15	43.72	41.02	42.81	46.51	36.80	42.38	7.18
White daisy (*Chrysanthemum leucanthemum* L.),	1	–	–	90.35	–	–	7.68	–	–	2.32	–	–	46.86	–	–	36.09	7.05
Dry carrot tops,	1	–	–	90.24	–	–	20.12	–	–	2.01	–	–	50.39	–	–	13.61	13.87
Wheat straw,	1	–	–	93.80	–	–	7.20	–	–	1.63	–	–	50.46	–	–	35.91	4.80
Barley straw,	1	–	–	88.56	–	–	9.24	–	–	3.38	–	–	48.23	–	–	33.85	5.30
Japanese millet (white head),	1	–	–	91.48	–	–	7.67	–	–	2.41	–	–	49.87	–	–	34.99	5.06
Japanese millet (red head),	1	–	–	91.13	–	–	5.76	–	–	1.70	–	–	49.66	–	–	39.52	3.36

Millet straw,	1	-	-	86.55	-	-	4.95	-	-	1.43	-	-	44.96	-	-	41.82	6.84
Straw (*Panicum crus-galli*),	1	-	-	87.35	-	-	6.10	-	-	2.44	-	-	50.20	-	-	35.90	5.36
Straw (*P. miliaceum*),	1	-	-	87.83	-	-	3.94	-	-	3.01	-	-	44.72	-	-	42.16	6.17
Straw (*P. Italicum*),	1	-	-	80.28	-	-	4.17	-	-	1.59	-	-	46.39	-	-	41.54	6.31
III. Roots, Bulbs, Tubers, etc.																	
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58
Beets, sugar,	12	19.53	9.87	14.60	17.44	7.32	11.18	.83	.58	.67	81.50	61.93	75.62	9.69	4.82	6.55	5.98
Beets, yellow fodder,	4	15.01	9.40	11.46	13.96	9.29	11.69	2.02	.84	1.39	75.22	61.90	69.33	9.66	7.26	8.14	9.45
Mangolds,	4	13.08	11.49	12.06	12.84	7.04	9.54	1.14	.73	.97	73.38	70.32	71.03	9.98	7.08	8.45	10.01
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75
Turnips,	4	12.80	8.22	10.11	11.12	9.67	10.37	2.05	1.42	1.68	70.62	65.91	57.37	13.34	10.12	11.75	8.83
Carrots,	4	12.52	9.95	11.15	9.75	7.98	9.13	3.94	1.41	2.11	73.96	67.24	70.12	10.76	7.55	9.09	8.55
Parsnips,	1	-	-	19.66	-	-	6.88	-	-	3.37	-	-	74.65	-	-	7.67	7.43
Potatoes,	10	21.95	13.91	18.78	13.56	6.24	10.01	.83	.17	.48	87.56	78.80	81.50	3.55	1.91	2.75	5.26
Artichokes,	1	-	-	22.51	-	-	12.82	-	-	.95	-	-	77.26	-	-	4.18	4.79
Japanese radish (*merinia*),	1	-	-	6.74	-	-	7.47	-	-	1.05	-	-	70.89	-	-	10.27	10.32
Japanese radish (*niyas hige*),	1	-	-	7.42	-	-	6.51	-	-	.96	-	-	72.87	-	-	9.79	9.87
IV. Grains, Seeds, Fruits, etc.																	
Corn kernels,	29	91.98	65.50	89.43	15.02	8.49	12.18	9.43	4.25	5.42	83.98	71.06	78.49	3.38	1.03	2.12	1.69
Sweet corn kernels,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Wheat kernels,	1	-	-	89.42	-	-	13.35	-	-	1.79	-	-	80.26	-	-	2.42	2.18

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
IV. Grains, Seeds, Fruits, etc. — Concluded.																	
Oat kernels,	1	–	–	86.84	–	–	14.44	–	–	6.83	–	–	66.21	–	–	9.03	3.49
Broom-corn seed,	1	–	–	85.90	–	–	11.21	–	–	4.05	–	–	74.05	–	–	8.34	2.35
Soja beans,	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84
Horse beans,	1	–	–	89.72	–	–	30.03	–	–	1.11	–	–	56.48	–	–	8.11	4.27
Red adzinki beans,	2	85.18	83.10	84.14	25.14	23.75	24.45	.88	.76	.82	66.48	65.41	65.95	4.68	4.50	4.59	4.19
Saddle beans,	1	–	–	87.62	–	–	15.12	–	–	16.58	–	–	57.34	–	–	4.75	6.21
Daidzu beans,	1	–	–	88.47	–	–	36.99	–	–	18.59	–	–	30.41	–	–	4.97	7.04
Millet seed,	3	87.32	86.11	86.65	14.60	11.76	13.24	4.94	3.53	4.32	73.19	66.94	70.56	10.23	6.48	8.88	3.00
Chestnuts,	1	–	–	55.14	–	–	13.32	–	–	14.46	–	–	67.05	–	–	2.45	2.72
Cranberries,	1	–	–	10.59	–	–	4.40	–	–	5.61	–	–	76.37	–	–	11.63	1.99
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08
V. Flour and Meal.																	
Corn meal,	34	89.95	79.81	86.24	16.08	9.73	11.04	5.08	3.10	3.83	83.61	73.20	81.41	3.60	1.20	2.15	1.57
Corn and cob meal,	37	94.00	80.89	89.47	15.06	7.82	10.01	5.27	3.36	4.19	81.41	70.13	76.62	10.41	5.63	7.54	1.64
Cooked feed (oats and corn),	1	–	–	94.45	–	–	14.75	–	–	5.34	–	–	67.14	–	–	8.73	4.04

Hominy meal,	4	-	-	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.72	33.77	31.36	32.93	1.21
Ground oats,	1	-	-	90.29	-	-	13.20	-	-	3.51	-	-	70.07	-	-	9.29	3.93
Ground barley,	4	89.09	82.59	86.44	14.93	10.42	12.46	2.38	1.69	2.10	78.25	74.47	76.83	7.37	4.10	5.84	2.77
Broom-corn meal,	1	-	-	86.46	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43
Pea meal,	1	-	-	91.15	-	-	20.95	-	-	1.67	-	-	55.02	-	-	19.42	2.94
Bean meal,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Soja-bean meal,	1	-	-	89.20	-	-	41.18	-	-	18.17	-	-	30.60	-	-	5.01	5.04
Millet meal (*Panicum Italicum*),	1	-	-	89.38	-	-	35.12	-	-	17.35	-	-	38.95	-	-	3.86	4.72
VI. By-products and Refuse.																	
Linseed cake, old process,	8	92.52	88.50	90.32	39.97	33.98	36.65	9.87	6.24	7.30	44.72	37.76	40.51	9.69	8.04	8.62	6.92
Linseed cake, new process,	7	94.94	88.17	91.65	41.02	35.03	39.38	4.08	2.17	3.24	46.49	40.54	41.74	10.31	8.59	9.28	6.36
Cotton-seed meal,	24	94.42	88.81	91.94	51.79	36.54	44.22	14.72	9.47	12.15	35.84	20.22	29.30	10.83	5.08	7.70	7.53
Wheat bran,	40	92.58	86.30	89.34	20.54	15.67	17.86	6.08	2.80	4.98	62.83	51.77	58.36	14.26	7.49	10.98	7.82
Spring-wheat bran,	3	91.03	87.26	88.67	19.54	16.19	17.78	5.46	5.37	5.41	59.39	56.54	57.50	13.75	10.84	12.02	7.29
Winter-wheat bran,	2	87.76	86.94	87.35	17.04	16.24	16.64	4.57	3.43	4.00	62.83	59.83	61.33	12.74	9.32	11.03	7.00
Wheat middlings,	7	90.75	87.57	89.76	20.07	15.13	17.19	6.46	3.19	5.40	74.30	58.03	62.46	11.21	1.40	8.46	6.49
Rye bran,	2	91.82	86.30	89.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.30
Rye middlings,	1	-	-	87.46	-	-	13.15	-	-	5.61	-	-	73.52	-	-	3.70	4.02
Pea bran,	1	-	-	92.86	-	-	10.31	-	-	1.16	-	-	39.04	-	-	46.16	3.33
Buckwheat middlings,	1	-	-	88.49	-	-	25.49	-	-	7.53	-	-	66.36	-	-	5.18	5.44
Gluten meal,	38	93.67	68.32	90.98	39.28	25.75	29.99	14.47	3.92	9.13	66.26	48.26	56.34	10.06	.41	3.59	.95
Gluten meal (Chicago),	2	92.71	88.89	90.80	33.34	30.19	31.76	9.22	6.56	7.89	-	-	57.97	-	-	.73	1.65

A. *Analyses of Fodder Articles* — Concluded.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —													
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
VI. By-products and Refuse — Concluded.																	
Gluten feed (Buffalo),	10	93.67	90.61	91.90	31.05	21.11	25.69	14.47	9.18	12.08	62.79	48.80	53.12	10.06	5.43	7.00	1.11
Gluten feed (Pope),	1	-	-	86.02	-	-	38.68	-	-	16.34	-	-	42.43	-	-	1.80	.75
Maize feed (Chicago),	3	91.40	90.25	90.95	29.40	21.33	25.47	7.90	6.15	6.96	62.12	53.85	58.27	9.65	7.93	8.53	.77
Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Glucose feed (Richardson),	1	-	-	93.68	-	-	23.12	-	-	11.67	-	-	52.41	-	-	11.67	1.13
Corn-germ meal,	1	-	-	90.65	-	-	28.26	-	-	11.82	-	-	42.49	-	-	9.18	8.25
Corn-germ feed,	1	-	-	92.45	-	-	10.81	-	-	12.17	-	-	62.10	-	-	14.05	.87
Corn screenings,	1	-	-	88.98	-	-	8.29	-	-	4.48	-	-	81.57	-	-	3.27	2.39
Proteina (mixed feed),	4	93.20	89.94	91.61	27.23	20.53	23.67	8.24	5.01	7.20	61.53	51.11	55.55	12.33	10.18	10.92	2.66
Excelsior feed,	1	-	-	92.92	-	-	6.75	-	-	5.42	-	-	65.75	-	-	14.65	4.43
Corn screenings,	1	-	-	88.98	-	-	8.29	-	-	4.48	-	-	81.57	-	-	3.27	2.39
Oat feed,	2	90.66	90.53	90.59	15.60	14.06	14.83	8.23	4.28	6.25	68.08	64.52	66.31	8.79	8.06	8.42	4.19
Rye feed,	1	-	-	90.37	-	-	13.56	-	-	2.79	-	-	77.51	-	-	3.52	2.62
Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Cocoanut meal,	1	-	-	90.67	-	-	22.61	-	-	12.88	-	-	40.03	-	-	18.80	5.68
Louisiana rice bran,	1	-	-	89.75	-	-	9.82	-	-	9.66	-	-	55.07	-	-	14.86	10.59

Bakery refuse,	1	-	-	86.66	-	-	9.23	-	-	6.36	-	-	72.34	-	-	.43	11.64
Vinegar mash,	1	-	-	5.51	-	-	16.50	-	-	8.45	-	-	63.47	-	-	8.55	3.03
Refuse from starch works,	1	-	-	42.96	-	-	22.41	-	-	10.17	-	-	58.98	-	-	7.54	.90
Oat meal and barley refuse,	1	-	-	92.24	-	-	7.45	-	-	3.80	-	-	62.61	-	-	22.30	3.84
Glucose refuse,	1	-	-	93.29	-	-	21.06	-	-	10.55	-	-	62.42	-	-	4.77	1.20
Spent brewers' grain,	4	93.02	88.00	90.13	33.16	16.08	23.29	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53
Malt sprouts,	1	-	-	84.63	-	-	27.17	-	-	3.85	-	-	47.92	-	-	14.75	6.31
Damaged wheat,	1	-	-	86.90	-	-	16.26	-	-	2.51	-	-	75.85	-	-	3.11	2.31
Cocoa dust from cocoa manufactory,	1	-	-	92.90	-	-	15.47	-	-	25.85	-	-	45.99	-	-	5.86	6.83
Broom-corn waste,	1	-	-	91.30	-	-	6.78	-	-	1.00	-	-	48.09	-	-	39.25	4.88
Refuse from cows' manger,	4	85.73	64.81	77.44	6.63	4.34	5.01	1.09	.74	.98	45.46	42.12	43.74	46.91	38.72	43.94	6.33
Refuse from cows' manger (ensilage),	6	39.89	21.73	27.07	11.56	8.64	8.38	2.04	1.30	1.48	44.96	41.67	45.97	40.37	33.98	34.57	9.60
Cotton hulls,	3	91.85	88.55	89.98	5.36	4.10	4.79	4.27	1.79	2.81	46.75	38.59	43.34	51.40	40.24	46.08	2.98
Apple pomace,	2	21.78	17.22	19.50	7.73	6.94	7.34	4.37	3.17	3.78	72.93	70.20	72.56	16.58	13.15	14.86	1.46
Apple pomace ensilage,	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21
Sugar beet pulp, from diffusion battery,	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04
Corn cobs,	6	94.05	90.00	92.35	4.15	1.46	2.91	.77	.38	.56	63.62	58.78	61.21	37.84	31.36	33.96	1.36
Palmetto root,	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.95	-	-	21.26	4.44

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.048	.153	.091	.018	.148	.380	$1 93
Fodder corn ensilage,	6	78.46	.341	-	.385	.050	.100	.090	.020	.129	.255	1 74
Corn and soja-bean ensilage,	1	71.03	.790	-	.444	-	-	-	-	.420	-	3 67
Ensilage of *Panicum miliaceum*,	1	78.01	.260	-	.430	-	-	-	-	.110	.500	1 49
Ensilage of *Panicum crus-galli*,	1	76.75	.294	-	.621	-	-	-	-	.133	-	1 84
Sorghum,	7	82.19	.233	-	.229	.025	.076	.075	.012	.088	.136	1 16
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	2 07
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 76
Millet (*Panicum crus-galli*),	1	75.11	.455	-	.494	-	-	-	-	.109	-	2 24
Green oats,	3	83.36	.489	1.31	.381	.217	.154	.134	.018	.130	.496	2 26
Green rye,	2	72.03	.302	-	.636	-	-	-	-	.117	-	1 87
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 78
Horse bean,	1	74.71	.675	-	.346	.028	.346	.157	.050	.083	.514	2 85
Soja bean,	1	73.20	.292	-	.531	-	-	-	-	.151	-	1 76
Soja bean (early white),	1	66.56	.943	-	.905	-	-	-	-	.214	-	4 51

Soja bean (early green),	1	69.84	.835	-	.707	-	-	-	-	.201	-	3 90
Soja bean (medium black),	1	76.87	.803	-	.566	-	-	-	-	.175	-	3 61
Soja bean (late),	1	79.78	.600	-	.677	-	-	-	-	.138	-	2 98
Kidney vetch,	1	80.85	.563	-	.346	.218	.907	.055	.027	.085	.155	2 46
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 39
Prickley comfrey,	1	86.79	.370	-	.759	.122	.309	.041	.058	.115	-	2 24
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	2 04
Common buckwheat,	1	84.65	.440	-	.538	-	-	-	-	.089	.577	2 22
Flat pea (*Lathyrus sylvestris*),	1	78.62	1.049	-	.449	-	.302	.088	.056	.140	.247	4.30
Hungarian grass,	1	74.31	.386	-	.549	-	-	-	-	.159	-	2 11
White lupine,	1	85.35	.440	-	.253	.100	.450	.107	.025	.051	.131	1 87
Yellow lupine,	1	85.05	.398	-	.441	.086	.288	.049	.008	.092	.161	1 49
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 30
II. Hay and Dry Coarse Fodders.												
English hay,	10	11.94	1.294	6.34	1.528	.110	.344	.240	.021	.286	.911	6 49
Rowen,	12	18.52	1.609	9.57	1.486	.140	.640	.280	.034	.432	1.840	7 70
Timothy hay,	3	11.26	1.240	4.93	1.460	.180	.620	.120	.006	.342	1.000	6 28
Red-top,	4	7.71	1.150	4.59	1.020	.438	.571	.134	.036	.360	1.736	5 51
Kentucky blue grass,	2	5.34	1.320	-	1.694	.129	.398	-	.044	.431	2.863	6 91

* The valuation is based on the following prices per pound of the essential fertilizing ingredients: nitrogen, 17½ cents; potassium oxide, 5½ cents; phosphoric acid, 5 cents.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
Orchard grass,	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	$7 07
Meadow fescue,	6	8.89	.992	8.08	2.096	.301	.576	.187	.028	.399	1.537	6 18
Perennial rye-grass,	2	9.13	1.227	6.79	1.553	.307	.642	.337	.044	.559	2.262	6 56
Italian rye-grass,	4	8.71	1.189	-	1.273	.451	.857	.321	.071	.556	2.598	6 13
Salt hay,	1	5.36	1.180	-	.718	.017	.371	.335	.028	.248	-	4 46
Japanese millet (white head),	3	10.45	1.105	5.80	1.223	.012	.465	.377	.028	.403	1.033	5 62
Common buckwheat,	1	8.50	2.620	-	3.208	-	-	-	-	.532	3.436	13 04
Silver-hull buckwheat,	1	8.91	1.780	-	2.380	-	2.290	.526	.059	.860	.462	9 71
Japanese buckwheat,	1	5.72	1.629	-	3.320	.349	3.418	.421	.148	.852	.378	10 21
Fodder corn,	7	7.85	1.763	4.91	.889	.175	.605	.500	.075	.542	1.270	7 69
Corn stover,	17	9.33	1.038	3.74	1.375	.112	.622	.384	.068	.288	1.782	5 43
Teosinte,	1	6.06	1.460	6.53	3.696	.109	1.597	.458	.021	.546	.315	9 72
Summer rape,	1	11.13	2.053	-	4.670	.994	3.691	.522	.031	.572	.709	12 89
Millet hay,	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.490	1.360	6 83
Mammoth red clover,	3	11.41	2.231	8.72	1.223	.389	3.141	.613	.111	.546	.779	9 98

Medium red clover,	2	7.91	**2.184**	8.36	**2.286**	.210	1.689	.402	.099	**.447**	.919	10 61
Alsike clover,	6	9.94	**2.342**	11.11	**2.227**	.309	2.153	.537	.197	**.668**	1.776	11 31
Lucerne (alfalfa),	4	6.26	**2.075**	6.82	**1.461**	.814	2.211	.406	.078	**.526**	.513	9 40
Bokhara clover,	2	7.43	**1.975**	7.70	**1.832**	.114	1.784	.347	.023	**.558**	.057	9 49
Blue melilot,	1	8.22	**1.919**	13.65	**2.796**	.270	1.449	.260	.349	**.544**	4.008	10 34
Sainfoin,	1	12.17	**2.630**	7.55	**2.020**	.540	1.160	.430	.040	**.760**	.470	12 19
Sulla,	2	9.39	**2.460**	-	**2.093**	.223	2.497	.350	.114	**.453**	.614	11 37
Lotus villosus,	2	11.52	**2.095**	8.23	**1.807**	.499	2.220	.476	.112	**.594**	.976	9 91
Soja bean,	2	6.30	**2.320**	6.47	**1.079**	.148	2.760	1.178	.115	**.667**	.977	9 97
Cow pea,	1	9.00	**1.635**	8.40	**.913**	.122	2.696	.688	.046	**.527**	.832	7 25
Small pea,	1	5.80	**2.497**	-	**1.990**	.469	1.373	.276	.138	**.592**	1.081	11 52
Flat pea (*Lathyrus sylvestris*),	1	8.90	**3.514**	-	**2.340**	-	1.631	.454	.179	**.820**	1.830	15 69
Serradella,	2	7.39	**2.697**	10.60	**.652**	.656	2.545	.461	.066	**.777**	.590	11 97
Scotch tares,	1	15.80	**2.964**	-	**3.004**	.238	1.698	.354	.460	**.815**	4.062	14 49
Spring vetch,	1	8.21	**2.204**	-	**2.760**	-	1.710	-	-	**.740**	.510	11 48
Vetch and oats,	3	9.91	**1.299**	9.58	**1.349**	.420	.663	.265	.098	**.560**	.521	6 59
Soja-bean straw,	1	13.00	**.714**	-	**1.060**	-	.436	.469	.035	**.259**	.218	3 92
Millet straw,	1	13.45	**.690**	-	**1.760**	-	-	-	-	**.180**	.580	4 63
White daisy,	1	9.65	**.279**	6.37	**1.253**	.164	1.302	.191	.032	**.435**	1.110	2 78
Dry carrot tops,	1	9.76	**3.130**	12.52	**4.883**	4.028	2.089	.667	.118	**.612**	.098	16 94
Barley straw,	1	11.44	**1.310**	5.30	**2.086**	.183	.572	.180	-	**.303**	2.380	7 18

* See note on page 359.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	8	87.82	.229	1.13	.440	.091	.049	.033	.004	.092	.020	$1 37
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.048	1 40
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	1 26
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 17
Ruta-bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 33
Turnips,	3	89.29	.163	1.01	.381	.078	.089	.027	.009	.115	.112	1 10
Carrots,	2	89.03	.162	9.22	.471	.062	.067	.023	.009	.090	.040	1 23
Parsnips,	1	80.34	.217	-	.617	.006	.088	.045	.005	.187	.019	1 63
Potatoes,	1	79.75	.207	.99	.294	.013	.007	.020	.002	.066	.006	1 11
Artichokes,	1	77.49	.460	-	.484	-	-	-	-	.168	.069	2 31
Japanese radish (*merinia*),	1	93.26	.081	-	.281	-	-	-	-	.047	-	0 64
Japanese radish (*niyas hige*),	1	92.58	.077	-	.338	-	-	-	-	.050	-	0 79
IV. Grains.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	7 52
Corn and cob meal,	29	8.96	1.409	-	.472	.059	.018	.176	.011	.571	.430	6 02

Oat kernels,	1	9.04	2.100	-	-	-	-	-	-	-	-	-
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	22 63
Red adzinki beans,	1	14.82	3.240	-	1.540	.035	.090	.210	.180	.940	.050	14 07
White adzinki beans,	1	16.90	3.330	-	1.480	.190	.130	.220	.021	.970	.130	14 14
Saddle beans,	1	12.38	2.120	-	2.130	.020	.250	.430	.032	1.520	.250	11 28
Daidzu beans,	1	11.53	5.520	-	1.960	.210	.220	.400	.050	1.480	.280	22 96
Japanese millet,	2	13.68	1.730	-	.380	.030	.045	.225	.015	.685	-	7 16
Common millet,	1	12.68	2.040	-	.360	.060	.040	.260	.030	.850	.143	8 38
Chestnuts,	1	44.86	1.175	2.72	.632	-	.060	.135	.010	.392	.069	5 51
Cranberries,	1	89.41	.075	-	.097	-	.018	.013	.005	.028	-	0 40
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57
V. Flour and Meal.												
Corn meal,	3	14.13	1.920	1.42	.337	.064	.034	.187	.015	.714	.060	7 80
Hominy feed,	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	7 22
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.669	6 46
Wheat flour,	2	12.14	2.020	1.22	.359	-	.170	.050	-	.352	-	8 89
Pea meal,	1	8.85 *	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	12 69
Soja-bean meal,	1	10.80	5.89	-	2.230	-	-	-	-	1.570	.280	24 64
VI. By-products and Refuse.												
Linseed meal, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	21 98
Linseed meal, new process,	5	7.96	5.828	5.04	1.246	.823	.663	.655	.062	1.692	.345	24 26

* See note on page 359.

B. *Analyses of Fodder Articles with Reference to Fertilizing Ingredients* — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Valuation per 2,000 Pounds.
VI. By-products and Refuse. — Concluded.												
Cotton-seed meal,	15	8.83	6.494	6.49	1.686	.291	.587	.589	.020	2.366	.322	$26 84
Wheat bran,	8	11.07	2.620	6.44	1.579	.159	.168	.899	.019	2.461	.182	13 37
Wheat middlings,	2	10.15	2.745	2.30	.750	.110	.200	.210	–	1.245	–	11 67
Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.320	.020	1.260	.170	8 59
Rye feed,	1	9.63	1.950	–	.980	–	–	–	–	1.561	–	9 46
Gluten meal,	5	8.53	5.090	.65	.047	.018	.050	.035	.009	.420	–	18 28
Gluten feed (Buffalo),	4	8.11	3.724	–	.060	–	–	–	–	.348	.160	13 45
Spent brewers' grain,	2	8.58	2.680	6.15	.853	.347	.296	.286	.159	1.045	1.770	11 36
Proteina,	1	10.06	2.970	–	.570	–	–	–	–	1.00	–	12 02
Damaged wheat,	1	13.10	2.260	–	.505	–	–	–	–	.831	–	9 30
Louisiana rice bran,	1	10.25	1.430	–	.840	–	–	–	–	1.710	–	7 64
Glucose refuse,	1	6.71	3.370	–	.090	–	–	–	–	.610	–	12 50
Cocoa dust,	1	7.10	2.299	6.35	.630	–	.630	–	–	1.340	–	10 08
Broom-corn waste (stalks),	1	10.37	.870	4.70	1.858	–	.242	.170	–	.460	1.000	5 55
Cotton hulls,	3	10.63	.750	2.61	1.080	–	.200	.260	–	.180	.060	3 99

Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	0 96
Corn cobs,	8	12.09	.504	.815	.598	.071	.025	.045	.009	.063	.190	2 48
Palmetto roots,	1	11.51	.540	3.93	1.380	.345	.045	.004	.017	.157	.410	3 57
Buckwheat hulls,	1	11.90	.490	–	.521	–	.247	.236	.020	.073	.066	2 36
VII. Dairy Products.												
Buttermilk,	1	91.13	.510	.810	.046	–	.045	–	–	.041	–	1 88
Skim-milk,	19	90.29	.586	.788	–	–	–	–	–	–	–	–
Whey,	1	93.68	.102	–	.0723	–	–	–	–	.173	–	0 62

* See note on page 359.

C. *Analyses of Fruits.*

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), . . .	Sept. 1,	20.14	1.055	12—15	3.09	-	-	-
Apple (Baldwin), . . .	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), . . .	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Rhode Island Greening, . .	Sept. 1,	20.27	1.055	12—15	3.16	-	-	-
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Rhode Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Pear (Bartlett), . . .	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Pear (Bartlett), . . .	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Pear (Bartlett), . . .	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Pear (Bartlett),‡ . . .	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Cranberries, ...	-	10.71	1.025	15	1.35	-	-	-§
Cranberries, ...	1878.	10.11	1.025	15	1.70	-	-	-‖
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Crawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Crawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Crawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.
† Picked October 9.
‡ Picked September 7.
§ Free acid, 2.25 per cent.
‖ Free acid, 2.43 per cent.
¶ In pulp, kept ten days before testing.

C. Analyses of Fruits — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord,	July 17,	1.0175	31	8.30	.645	7.77	–
Concord,	July 20,	1.0150	31	8.10	.625	7.72	216
Concord,	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord,	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord,	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord,	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord,	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape,	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape,	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape,	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape,	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape,	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific,	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' seedling,	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona,	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed),	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam,	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder,	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware,	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak,	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella,	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling,	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack,	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba,	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder,	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak,	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord,	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord,	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan,	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape,	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled),	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled),	Sept. 20,	1.045	16	16.69	8.22	49.25	104

* One part of pure Na_2CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled,	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled,	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled,	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled,	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled,	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled,	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled,	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled,	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
Iona, not girdled,	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled,	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled,	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled,	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled,	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled,	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled,	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled,	Oct. 5,	1.085	12	–	17.86	–	54

	Date.	100 PARTS OF GRAPES CONTAINED — Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled,	Sept. 23,	–	84.69	6.24	.75
Concord, girdled,	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled,	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled,	Oct. 8,	.37	82.69	8.50	.50
	1890.				
Concord, not girdled,	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled,	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled,	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled,	Oct. 9,	.59	85.11	6.65	.51
Concord, girdled,	Oct. 9,	.54	85.15	9.12	.74

* One part of pure Na_2CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	–	–	8.03	–	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	–	–	13.51	–	Fertilized.
Wild Purple Grape Juice, .	"	–	1.045	16	8.22	9 840	Unfertilized.
Wild Purple Grape Juice, .	"	–	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	–	–	–	–	Unfertilized.
Wild White Grape Berries, .	"	21.65	–	–	–	–	Fertilized.
Wild White Grape Juice, .	"	–	1.060	16	10.00	1.846	Unfertilized.
Wild White Grape Juice, .	"	–	–	–	14.29	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.80	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	–	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.87	5.80	Fertilized.

C. Analyses of Fruits — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 Parts of Ash contained — Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit),	–	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice,	–	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice,	–	40.69	–	6.85	6.24	–	9.04	–
Skins and pulp,	–	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds,	3.08	6.71	–	–	3.03	–	17.20	.29
Stems of grapes,	4.69	20.91	–	20.20	8.45	–	17.75	2.09
Young branches,*	–	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,†	2.97	22.57	–	9.72	4.28	–	14.07	23.84
Concord Grapes, 1891,‡	.55	49.76	–	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit),	–	58.45	3.51	13.34	7.37	.90	18.19	–
Baldwin Apple,	–	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),||	–	58.47	–	14.64	6.12	3.37	17.40	–
Strawberry vines,	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit),	.18	47.96	6.58	18.58	6.78	–	14.27	–
Cranberry vines,	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red,	.47	47.68	4.02	18.96	6.23	1.20	21.91	–
Currants, white,	.59	52.79	3.00	17.08	5.68	2.67	18.78	–
Crawford Peach, sound,	–	74.46	–	2.64	6.29	.58	16.02	–
Crawford Peach, diseased,¶	–	71.30	–	4.68	5.49	.46	18.07	–
Branch, sound,	–	26.01	–	54.52	7.58	.52	11.37	–
Branch, diseased,¶	–	15.67	–	64.23	10.28	1.45	8.37	–
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems,	–	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots,	–	56.43	5.42	15.48	7.57	–	15.09	3.67
Onions,	–	38.51	1.90	8.20	3.65	.58	15.80	3.33

* With tendrils and blossoms.
† One year old.
‡ Nitrogen in dry matter, .96 per cent.
§ Wilder.
|| Downing.
¶ Yellows.
** Nitrogen in dry matter, 1.15 per cent.

D. Analyses of Sugar-producing Plants.

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, ...	Sept. 10,	14	12.30	1.75
Imperial, ...	" 12,	15	12.59	2.41
Vilmorin, ...	" 13,	14.5	12.95	1.55
Imperial, ...	" 18,	14	10.79	3.21
Imperial, ...	Oct. 11,	15	12.05	2.95
Electoral, ...	" 16,	15	12.22	2.78
Vilmorin, ...	" 18,	16	13.13	2.87
Imperial, ...	Nov. 14,	15	11.60	3.34
Vilmorin, ...	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept. 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, ...	Saxony, .	$\frac{3}{4}$ to $\frac{7}{8}$	15.50
II. Vilmorin, ...	Saxony, .	$\frac{3}{4}$ to 1	15.61
I. White Imperial, ...	Saxony, .	$\frac{3}{4}$ to $1\frac{3}{4}$	14.20
II. White Imperial, ...	Saxony, .	$1\frac{3}{4}$ to 2	10.27
New Imperial, ...	Saxony, .	$1\frac{1}{4}$ to $1\frac{3}{4}$	13.80
I. White Magdeburg, . . .	Saxony, .	$1\frac{1}{2}$ to 2	13.10
II White Magdeburg, . . .	Silesia,	$1\frac{1}{2}$ to $1\frac{3}{4}$	10.06
Quedlinburg, ...	Saxony, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	13.44
White Silesian, ...	Silesia, .	$1\frac{1}{4}$ to $1\frac{1}{2}$	9.72

D. Analyses of Sugar-producing Plants — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam,	Fresh yard-manure,	16.5	12.50	4.00	75.08
Clayish loam,	Fresh yard-manure,	15.5	11.05	4.45	71.30
Warm alluvial,	Yard-manure and chemicals,	12.75	9.17	3.58	71.92
Warm alluvial,	Fresh hog-manure,	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure,	18.5	13.73	4.77	74.21
Alluvial soil,	Brighton fish,	14.5	11.15	3.35	76.90
Heavy soil,	Yard-manure,	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure,	11.96	9.42	7.80
Blood guano without potash,	10.99	10.10	10.20
Blood guano with potash,	12.55	13.24	10.50
Kainite and superphosphate,	13.15	12.16	10.50
Sulphate of potash,	14.52	14.32	12.78
Second year after stable-manure,	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college).

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

Locality of Beet-field.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y.,	1872-73	11	7.80	3.20
2. Washington, N. Y.,	"	14	10.97	3.03
3. South Hartford, N. Y.,	"	15	11.70	3.30
4. Greenwich, N. Y.,	"	12	9.50	2.50
5. Frankfort, N. Y.,	"	13.5	11.00	2.50
6. Albion, N. Y.,*	"	18	15.10	2.90
Albion, N. Y.,†	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

Where Grown.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal,	2 to 2½ lbs	15.4°	64° F.	11.38
Riviere du Loup,	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly,	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge,	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

Date.	Condition of Cane.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15,	No flower stalks in sight, *	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight, *	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,*	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,*	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,*	13.2	22	3.57	7.65	–	–
Sept. 18,	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21,	Juice from the above,*	13.0	21	–	–	–	–
Sept. 23,	Juice from the above,*	15.0	18	–	–	–	–
Sept. 25,	Left on field 3 weeks,†	19.8	21	11.91	6.27	–	–
Sept. 28,	Left on field 3 weeks,†	17.8	12	16.60	–	–	–
Oct. 4,	Left on field 3 weeks,†	16.1	17	8.62	6.16	12.0	–
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14,	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18,	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19,	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22,	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23,	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24,	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 Parts of Cane contained —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	Grown on station grounds.
October,	Price's new hybrid, ripe,	77.80	2.92	3.78	6.70	
October,	Kansas orange, green,	80.67	2.38	3.63	6.01	
October,	New orange, green,	78.30	2.96	3.85	6.81	
October,	Honduras, green,	77.55	3.08	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,† . . .	1.052	–	4.85	5.70	20.38
Common sweet corn,‡ . . .	1.035	–	6.60	None.	–
Common yellow musk-melon,§ .	1.040	26	1.67	2.65	–
White-flesh water-melon, . .	1.025	18	2.91	2.16	–
Red-flesh water-melon, . . .	1.025	22	3.57	2.18	–
Red-flesh water-melon, . . .	1.025	19	3.84	1.77	–
Nutmeg musk-melon,‖ . . .	1.030	19	3.33	2.11	–
Nutmeg musk-melon,¶ . . .	1.050	20	2.27	5.38	–
Nutmeg musk-melon,** . .	1.030	19	2.50	1.43	–

* Tassels appearing.
† Ears ready for the table.
‡ Kernels somewhat hard.
§ Fully ripe.
‖ Not ripe.
¶ Ripe.
** Over-ripe.

E. Analyses of Dairy Products.

	Analyses.	Solids.			Fat.			Curd.			Salt.			Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	
Whole milk,	1,738	18.27	10.58	13.49	7.54	1.72	4.14	-	-	3.20	-	-	-	.70
Skim-milk,	328	10.40	7.68	9.48	1.02	.05	.39	-	-	3.53	-	-	-	.80
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	2.79	-	-	-	.80
Cream (from Cooley Creamer),	176	32.78	19.93	26.47	25.00	13.11	17.98	-	-	-	-	-	-	.62
Butter,	25	92.89	87.05	89.11	89.05	81.43	83.95	.89	.51	.66	6.45	3.46	4.74	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole milk cheese,*	1	-	-	64.17	-	-	34.34	-	-	26.69	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.99	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

* From analyses made in 1875.

E. Salt for Meat Packing and Dairy Purposes.

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Pettite Anse, La.,	.330	98.882	.782	.004	.003	–	–	–	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	–	.090	.070	.070	–	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	–	–	–	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	–	–	–	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	–	–	–	
Solar salt from Kansas,	4.950	93.060	1.220	–	.240	.350	.180	–	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	–	.080	.390	None.	–	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	–	–	–	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	–	–	–	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	–	.614	.041	–	–	–	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	–	.060	–	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	–	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	–	–	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	–	–	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	–	–	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	–	–	.072	
Ashton salt (sent on),	.760	97.650	1.430	–	.060	–	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	–	–	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	–	–	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	–	–	.700	
Royal salt,	.880	97.877	1.108	.016	.010	–	–	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	–	–	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	–	–	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	–	–	–	
Bradley salt,	.200	98.575	1.185	.029	.007	–	–	–	
Higgins' Eureka salt,	.855	98.891	.906	.293	.055	–	–	–	
Worcester refined salt,	.565	97.935	1.376	.097	.027	–	–	–	

F. *Analyses of Insecticides.*

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
Paris green,	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green,	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green,	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green,	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green,	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green,	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green,	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green,	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor,	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

VI. Tables of the Digestibility of American Feed-Stuffs.

Experiments made in the United States.

Compiled by J. B. LINDSEY.

I. Experiments with Ruminants.

II. Experiments with Swine

Dec. 31, 1893.

TABLE OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Experiments.	Number of Animals.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.									
Timothy hay, in bloom,	7	8	13	55.6—65.7 60	56.1—66.8 60	49.6—62.1 56	42.8—75.9 57	40.9—60.4 48.5	58—71.8 65
Timothy hay, past bloom,	4	4	8	47—61.1 53	50.4—62.3 54.5	37.2—56.8 47	54.5—61.1 52	38.8—50.4 45	57.7—67 60
Hay of mixed grasses, poor in nitrogen,	1	1	2	-	-	49	50	40	58
Hay of mixed grasses, rich in nitrogen,*	2	2	7	55.10—62 58	- -	55.90—65.86 60	45.65—57.04 49	56.08—63.76 60	56.80—63.46 60
Clover and timothy hay poorly cured,	1	1	2	54.3—55.3 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay,	1	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Cow-pea-vine hay, fair quality,	1	1	2	- 59	- -	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	- 71
Clover hay, late bloom, fair quality,	1	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay, good quality,	1	2	2	50.8—53.5 52	51.6—54.5 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay, bloom,	1	1	2	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	1	1	2	59.4—65 62	- -	42.6—54.8 49	43.7—54 49	68.5—69.7 69	69.3—73.6 72

Alsike clover (*T. hybridum*),	2	2	4	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	61—69.2 66	66.5—74.1 71
Alfalfa (lucerne), late bloom,	1	1	2	-	-	49	54	77	64
Alfalfa (lucerne), stage not given,	1	1	1	-	-	43	48	69	72
Alfalfa, average both samples,	2	2	3	-	-	46	51	73	68
Hay of blue-joint grass, past bloom,	1	1	2	40	42	37	37	57	43
Hay of blue-joint grass, bloom,	1	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass, ten days after bloom,	1	1	2	54	56	58	54	59	54
Hay of orchard grass, stage not given,	1	1	2	57.5—60 59	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56
Average of both samples,	2	2	4	56	56	61	55	60	55
Hay of red top,	2	2	4	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Hay of wild oat grass (*Danthonica spicata*),	2	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	1	2	56	57	41	70	56	67
Hay of white weed (*Leucanthemum vulgare*),	1	1	2	58	58	46	62	58	67
Soja-bean hay, low in nitrogen,	1	1	2	-	-	58	54	70	82
Dried pasture grass,	1	1	1	71	-	77	60	72	73
Oat straw,	1	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	- -	51.8—54.6 53

* Above ten per cent. protein.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Experiments.	Number of Animals.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders — Concluded.									
Cotton-seed hulls,	3	3	9	35—47.5 41	- -	0.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Raw cotton seed,	1	2	1	62.9—69.3 66	- -	65—85.9 76	- 87	65.7—70 68	49.2—50 50
Roasted cotton seed,	1	1	2	53.5—58.4 56	- -	62.5—69.3 66	68.5—75 72	44.3—49.6 47	49.8—53 51
Corn stover, whole plant,	1	2	2	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover, tops and blades,	1	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Pulled stover, leaves,	1	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.15—68.76 56	57.1—60.65 59
Field corn fodder, ears glazing or glazed,	5	5	10	58.8—71.8 67	- -	53.4—80 70	66.7—79 73	44—64.6 53	61—73.4 68
Field corn fodder, ears glazed, very coarse (sheep),	1	1	2	57.6—63.9 61	- -	66.7—74.3 71	65.6—84.2 75	22.4—35.9 29	59.9—65.5 63
Southern corn fodder, no ears formed,	2	2	4	63.6—70.3 67	65.3—71.4 69	71.7—77.5 74	68.1—72.3 70	57.2—66.1 62	62.8—70.4 67
Corn stalks, below ear,*	1	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover, part above ear,*	1	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54

Corn husks,*	1	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves, below ear,*	1	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 35	66—70 68
Green Fodders.									
Corn fodder, quite young,	1	1	2	67.2—70.2 69	- -	73.8—75.6 75	37.5—42.5 40	76.4—79.9 78	64—67.7 66
Dent corn fodder, ears not begun to form, thick seeded,	1	1	2	71.3—73.7 72	- -	70.8—72. 71	76.1—81.6 79	72.5—75.2 74	74.6—75.3 75
Dent corn fodder, ears well formed, thick seeded,	1	2	2	70.9—73.4 72	- -	64.8—68. 66	81.2—83.8 83	56.3—63.7 60	76.7—78.8 78
Dent corn fodder, ears just forming, thin seeded,	1	2	2	67.2—68 68	- -	60—61.4 61	71.6—73.3 73	55.9—56.8 56	74 -
Corn fodder, ears glazing (Burrill & Whitman coarse),	1	1	2	50.88—53.66 52	- -	45.5—46.6 46	74—82 78	20.13—28.14 24	57—61.4 59
Sweet corn fodder, ears in milk,	1	1	2	76.5—78 77	- -	74.2—75.5 75	73.4—74.4 74	77.3—77.6 77	79.6—81.4 81
Sweet corn fodder, ears in milk, partially dry,	2	2	4	60.1—70.2 65	62.4—73.9 68	69.5—76.9 73	66.9—71.3 72	54.6—63.5 61	57.4—72.5 66
Average of three samples,	3	3	6	71	-	74	73	69	73
Early amber sorghum, just after blossom,	1	2	2	60.9—61.7 61	- -	41.7—45.3 42	67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom, variety not stated,	1	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78.7 78
Average both samples,	2	3	4	67	-	59	74	46	74

* Made at Maryland Experiment Station. It will be noticed that the coefficients of protein digestibility are very much below those obtained in other experiments. The animals were fed but six pounds each per day, with no other food, and it is probable that the metabolic nitrogen products excreted were in a measure at least the cause of the low results obtained.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Experiments.	Number of Animals.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Green Fodders — Concluded.									
Field corn ensilage, ears glazing,	8	9	16	51.5—69.9 62	62—69.9 65	43—77.8 63	66—90 80	21—57.6 43	52.6—75.6 68
Fine crushed silage (steers),	1	1	2	60.4—68 64	– –	71.6—77.6 75	74.7—76.6 76	32.4—44 38	59.8—69.7 65
Fine crushed silage (sheep),	1	1	2	51.5—56 54	– –	59.5—67.7 64	67.5—69 68	21—22 21.5	52.6—57.3 55
Corn silage, raw, ears mature,	1	1	1	–	–	59	86	45	71
Same, cooked,	1	1	1	–	–	70	87	39	75
Sweet corn ensilage, occasional ears mature,	1	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Southern corn ensilage, ears not formed,	1	1	2	60.6—65.9 63	63.8—68.7 66	71.4—76.2 74	64.3—66.2 65	42—51.3 47	63.3—67.9 66
Soja-bean ensilage,	1	1	2	52.2—65.8 59	– –	47.1—62.5 55	66.4—77.3 72	71.3—80.2 76	45.9—58.2 52
Green grass, young,	1	1	1	69	–	74	55	65	72
Same, dry,	1	1	1	71	–	77	60	71	73
Pasture grass,	1	1	2	71.9—75.6 74	– –	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	–	–	–	71	–	76	63	70	73
Soiling rye, formation of head,	1	1	2	73.2—74 74	– –	78.9—80.4 80	73.6—74.8 74	78.6—79.7 79	69.7—71.4 71

Soiling clover, late blossom,	1	1	2	64.9—67.3 66	- -	52.3—52.9 53	63—66.1 65	65.8—68.3 67	76.1—79.3 78
Hungarian grass, probably in bloom,	1	1	4	61—67 63	63.4—68.8 66	65.4—71.7 68	47.8—56 52	59.4—66.4 62	63.5—68.4 66
Roots, Tubers, etc.									
Potatoes,	1	1	2	73.3—80.1 77	74.6—81.2 78	- -	13 -	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	- -	69.7—79.8 75	90.8—91.9 91
English flat turnips,	1	1	2	90.7—94.9 93	93.2—99 96	89.2—117 100	82.5—92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains.									
Corn meal, maize,	1	1	2	82.5—86.7 85	- -	- -	87—96.9 92	56.9—59.6 58	85.2—89.1 87
Pea meal,	1	1	2	85.1—88.5 87	86.4—89.5 88	25.5—26 26	52.1—56.9 55	80.5—85.9 83	92.8—94.5 94
By-products.									
Cotton-seed meal,	1	1	2	80.8—82.2 82	80.3—81.8 81	- -	100 -	88.2—89.4 89	67.3—70.4 69
Gluten meal,	1	1	2	84.7—90.2 87	86.3—91.9 89	33 -	85.6—90.1 88	83—90.2 87	88.2—93.5 91
Wheat bran,	4	4	7	54.4—66.45 61	59.5—68.5 63	20—56.28 25	59.5—84.5 72	70.1—82.7 78	58.6—71.22 68

Table of the Digestibility of American Feed Stuffs — Concluded.

KIND OF FODDER.	Number of Different Samples.	Number of Experiments.	Number of Animals.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products — Concluded.									
Wheat middlings,*	1	1	2	72.6—72.2 75	75.1—79.3 77	- -	84.1—86.1 85	78.4—79.4 79	80.7—84.5 83
Wheat middlings,†	1	1	2	79.48—85.63 83	- -	32.57—40.06 36	81.71—87.98 85	81.83—87.75 85	84.43—91.08 88
Malt sprouts,	1	1	1	67	68	34	100	80	69
Buffalo Gluten feed,	1	1	2	75.53—80.44 78	- -	39.92—46.28 43	80.58—82.25 81	83.94—85.97 85	78.44—84.37 81
New-process linseed meal,	1	1	2	79.86—82.60 81	- -	49.24—73.21 61	90.50—91.52 91	86.32—88.16 87	84.71—86.31 86
Old-process linseed meal,	1	1	3	75.48—82.25 79	- -	37.80—71.47 57	85.3 —92.01 89	86.38—93.38 89	75.58—78.73 78
Corn cobs,	1	1	2	58.51—60.43 59	- -	64.50—66.15 65	44.22—56.00 50	12.89—21.88 17	59.71—60.37 60
Dried brewers' grains,	1	1	2	61.63—61.68 62	- -	50.04—55.11 53	89.43—92.79 91	77.71—80.82 79	58.70—58.96 59
Spring wheat bran,	1	1	2	62.26—62.80 63	- -	22.18—25 24	75.53—75.67 76	77.68—81.59 80	69.55—71.22 70
Winter wheat bran,	1	1	1	66	-	56	61	79	70

II. — Experiments with Swine.

Maize kernels, whole,	1	1	1	83	83	38	46	69	89
Maize meal,	2	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal, with cobs,	1	1	1	76	77	29	82	76	84
Pea meal,	1	1	1	90	92	78	50	89	95
Barley meal,	1	1	1	80	80	49	57	81	87
Wheat shorts,	1	2	2	74—79 77	– –	25—48 37	– –	71—75 73	85.5—88 87
Wheat bran,	1	2	2	53.7—68.6 61	– –	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66

* Jordan.

† Very fine and quite light in color. Lindsey.

Remarks on the Above Tables of Digestibility.

The various reports and bulletins published by the different experiment stations in the United States have been examined, and results of the digestion experiments reported carefully tabulated. It is believed that in many cases these figures can be taken as a very fair representation of the digestibility of American feed stuffs. The writer recognizes the great amount of work done by German investigators in this line, and believes further that in many cases it would not be advisable to repeat this work. It has been suggested, for example, that our climatic conditions being to a considerable degree different from those prevailing in Germany, such influences would cause a considerable difference in the composition and digestibility of many of our fodder articles. It must not be lost sight of, however, that our own country possesses very much wider ranges of climate than are to be found in the entire German empire; and, if climatic influences do cause noticeable variations, then a wider variation would exist between the grass grown in Maine and in North Carolina than between that grown in Hohenheim and Munich. There are, however, many coarse fodder articles and by-products peculiar to the United States which are well worthy of study, and upon which considerable work needs to be done.

It can be stated that in the digestion experiments here tabulated the coarse fodders have with few exceptions been fed alone, while in the case of grains, by-products and roots, the digestibility of hay has first been determined, and then a certain portion of the hay replaced by roots or grains.

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890.

Bulletins 87*d*, 80*c* and 81 of the North Carolina Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletin No. 26 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletin No. 20 of the Maryland Experiment Station.

Eleventh Annual Report (1893) of the Massachusetts State Experiment Station.

METEOROLOGY.

C. H. Johnson.

1893.

The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness are recorded each day, at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same time. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the New England Weather Service at Boston, and during the summer months partial monthly reports have been furnished for the use of the secretary of the State Board of Agriculture.

The most conspicuous meteorological phenomena of the past year (1893) will be briefly considered here, while the following tables will show the average monthly temperature, precipitation, prevailing direction of the wind, etc.

The winter of 1893 was exceptionally cold, the mean temperature of January, February and March being 21.88°.

There was no snow on the ground at the beginning of the year, the first fall worthy of mention occurring on January 10, giving 5.5 inches. The heaviest snowfall of the year was on February 22, amounting to 17 inches. The total amount of snow falling during the season was 71.25 inches. As the weather remained cold, the amount of snow after the first fall did not decrease very much, and the ground was protected until the heavy rains of the 12th and 15th of March.

The mean temperature for January was 14.39°, it being the coldest month since January, 1888, when the mean was 12.5°, as recorded at this station. The mean temperature from the 4th to the 24th of January, 1893, was 8.23°, the absolute minimum temperature during that time being —13°, on the 17th, which was the coldest day of the season. There being no snow on the ground until January 10, the frost penetrated to a depth of 4 feet in places.

The month of February was also characterized by low temperature, the mean being 21.57°, which is about 3° below the average for that month. The total snowfall for the month of February, viz., 48 inches, was much above the average. A storm occurred on the 10th, giving 10 inches, and one on the 22d, giving 17 inches. The latter was accompanied by a heavy wind, which piled the snow in drifts.

The first of March there was snow on the ground to the depth of 15 inches, but heavy rains of the 12th and 15th removed nearly all of it, leaving the ground protected only in sheltered places. There was a thunder-storm the night of March 14.

The mean temperature of April and May was 48.82°, being about 2° below the average. The month of April was unusually cold, with strong north-westerly winds. Seven inches of snow fell during the month, and on the morning of the 26th the surface of the ground was frozen to the depth of 1 inch, the temperature going as low as 25°. Thus, owing to the low temperature of this month, the spring season was backward.

The average mean temperature for June, July and August was 67.38°, being about the normal. The total precipitation amounted to 8.91 inches, being 3.55 inches below the normal.

The rainfall for July, viz., 2.59 inches, was 2 inches below the average.

Thunder-storms were of frequent occurrence during July and August, but were of short duration. The want of rain injured the vegetation in this section.

On the 24th and 29th of August there were rain-storms, accompanied by unusually heavy winds, which did consider-

able damage to crops, blowing much fruit from the trees and injuring many fruit and shade trees.

The mean temperature for September, viz., 55.70°, was 4° below the normal. There was a slight frost on the 3d, which was the first of the season, but there were no damaging frosts during the month. The rainfall was about 1 inch below the normal.

The mean temperature for October was about 3° above the normal, while the rainfall was about the normal.

The mean temperature for November was about the normal, while the precipitation was 1 inch below. There was a slight fall of snow on the 3d, some of the surrounding hills being white.

The mean temperature for December was 24.60°, being 2° lower than that for December of last year. The minimum temperature of the month (—13° F.) came on the 14th. A snow-storm on the 4th, giving about 6 inches, with small additions at intervals, furnished good sleighing during the month.

Summary of Meteorological Observations, 1893.

	Temperature, Degrees Fahrenheit.														
	7 A.M.	2 P.M.	9 P.M.	Mean.	Mean Maximum.	Mean Minimum.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	Greatest Daily Range.	Date.	Least Daily Range.	Date.	Mean Daily Range.
January,	13.39	21.84	14.39	14.48	24.64	4.97	50.00	2d	-13.00	17th	32.00	22d	9.00	5th	19.68
February,	18.25	27.50	22.97	21.57	31.07	12.07	49.00	10th, 15th	-6.00	6th	47.00	6th	3.00	13th	19.00
March,	25.68	36.35	29.81	29.59	38.90	20.29	48.00	14th	3.00	3d	30.00	30th	4.00	11th	18.61
April,	37.50	49.10	41.70	41.90	51.93	31.86	66.00	1st	20.00	3d, 7th	35.00	1st	7.00	15th	20.06
May,	51.90	64.68	54.86	55.74	67.42	44.06	84.00	23d	31.00	8th	43.00	11th	9.00	3d, 27th	23.36
June,	61.90	74.66	64.76	66.53	77.90	55.16	93.00	20th	43.00	2d	38.00	10th	6.00	23d	22.74
July,	63.96	76.64	63.84	67.50	80.26	54.74	90.00	22d	42.00	25th	37.00	21st	11.00	29th	25.52
August,	62.84	77.77	65.55	68.13	80.87	56.00	94.00	10th	40.00	14th	39.00	9th	9.00	20th	24.87
September,	49.80	65.06	54.30	55.71	68.20	43.23	81.00	10th	31.00	27th	40.00	9th	10.00	15th	24.97
October,	52.58	60.68	50.03	51.79	63.71	39.87	79.00	9th	22.00	31st	41.00	17th	8.00	4th	23.84
November,	34.00	44.53	35.40	37.06	46.80	27.33	62.00	2d	10.00	27th	33.00	11th	4.00	29th	19.36
December,	21.40	28.60	25.20	24.60	34.20	15.00	52.00	25th	-13.0	14th	35.0	26th	5.0	29th	19.10
Sums,	493.20	627.41	522.81	534.60	665.90	404.58	-	-	-	-	-	-	-	-	261.11
Mean,	41.10	52.28	43.57	44.55	55.49	33.72	-	-	-	-	-	-	-	-	21.76

Summary of Meteorological Observations, 1893.

January, February, March, April.

	1892.	Date.	1893.	Date.
Mean temperature,	31.43°	-	26.89°	-
Absolute maximum temperature,	76.00°	Apr. 5,	66.00°	Apr. 1.
Absolute minimum temperature,	—10.00°	Jan. 17,	—13.00°	Jan. 17.
Mean monthly range,	18.84°	-	19.34°	-
Total precipitation (inches),	9.74	-	15.53	-
Total snowfall (inches),	34.00	-	71.25	-
Last snowfall (inches),	trace	Apr. 10,	trace	Apr. 21.
Prevailing wind,	N. E. & N. W.	-	N. W.	-

May, June, July, August.

	1892.	Date.	1893.	Date.
Mean temperature,	65.32°	-	64.47°	-
Absolute maximum temperature,	94.50°	June 14,	94.00°	Aug. 10,
Absolute minimum temperature,	30.00°	May 1,	31.00°	May 8.
Mean monthly range,	21.21°	-	24.12°	-
Last frost,	-	May 10,	-	May 8.
Total precipitation (inches),	17.97	-	13.38	-
Prevailing wind,	S. W.	-	N.	-

September, October, November, December.

	1892.	Date.	1893.	Date.
Mean temperature,	43.28°	-	42.29°	-
Absolute maximum temperature,	79.00°	Sept. 18, 19, 25,	81.0°	Sept. 10.
Absolute minimum temperature,	—1.00°	Dec. 27,	—13.0°	Dec. 14.
Mean monthly range,	18.47°	-	21.82°	-
First frost,	-	Sept. 30,	-	Sept. 3.
Total precipitation,	7.50	-	14.31	-
First snowfall (inches),	trace	Nov. 5,	trace	Nov. 4.
Total snowfall (inches),	5.43	-	15.25	-
Prevailing wind,	N. W.	-	N. W.	-

Entire Year.

	1892.	Date.	1893.	Date.
Mean temperature,	45.68°	-	44.55°	-
Total precipitation (inches),	35.21	-	43.22	-
Total snowfall (inches),	39.43	-	86.50	-

Summary of Meteorological Observations, 1893.

1893.	Precipitation, Inches.					Mean Dew Point.				Relative Humidity. Per Cent.				Wind.	Casual Phenomena. — Dates.			
	Total Amount.	Date of Greatest Fall.	Total Snow-fall.	Depth of Snow the 15th.	Depth of Snow at End of Month.	7 A.M.	2 P.M.	9 P.M.	Mean.	7 A.M.	2 P.M.	9 P.M.	Mean.	Prevailing Direction.	Thunder-storms.	Solar Halos.	Lunar Halos.	Aurora.
January, . .	2.70	1, 2,	13.25	3.00	7.00	-	-	-	-	-	-	-	-	N. W.	-	18, 31,	29,	-
February, . .	5.55	22,	48.00	7.00	15.00	-	-	-	-	-	-	-	-	N. W.	-	11, 12, 28,	1,	5, 15
March, . .	3.62	11, 12,	3.00	-	-	-	-	-	-	-	-	-	-	N. W.	14,	7, 14, 27,	31,	-
April, . .	3.66	7, 8,	7.00	-	-	-	-	-	-	-	-	-	-	N. W.	8,	10, 12, 24,	2, 26,	-
May, . . .	4.37	3, 4,	-	-	-	-	-	-	-	-	-	-	-	N. W.	23, 30,	2, 10, 20, 23, 25,	22, 28,	-
June, . . .	2.93	22, 23,	-	-	-	58.70	63.00	59.70	60.46	89.76	69.13	86.10	81.66	N.	4, 6, 11, 30,	7, 14, 16,	-	-
July, . . .	2.59	8,	-	-	-	59.81	63.45	59.71	60.87	87.00	65.09	86.81	79.63	S. W.	1, 3, 5, 8, 10, 12, 17, 18, 22, 25, 26,	22, 25, 28, 30, 31,	28,	-
August, . .	3.49	29,	-	-	-	59.68	64.54	60.29	61.50	90.68	64.74	80.58	78.63	N.	1, 7, 12, 18, 19, 26, 27,	4, 28,	-	-
September, .	2.57	7,	-	-	-	46.97	53.26	49.36	49.86	90.26	63.74	83.40	79.13	S. W.	7,	1, 21, 26,	27,	-
October, . .	4.45	28,	-	-	-	-	-	-	-	-	-	-	-	S. W.	-	1, 13,	20, 22,	2,
November, .	2.66	28,	-	-	-	-	-	-	-	-	-	-	-	S. W.	-	7, 8, 9, 21, 23,	23,	3,
December, .	4.63	3, 4,	15.25	8.00	4.00	-	-	-	-	-	-	-	-	N. N. W.	-	-	21,	-
Sums, . .	43.22	-	86.50	-	-	225.16	244.25	229.06	232.69	357.70	262.70	336.89	319.05	-	-	-	-	-
Mean, . .	3.60	-	-	-	-	56.29	61.03	57.26	58.17	89.42	65.67	84.22	79.76	N. W.	-	-	-	-

ANNUAL REPORT OF C. A. GOESSMANN,

TREASURER OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION

For the Year Ending Dec. 20, 1893.

RECEIVED.

Cash on hand from last year,	$462 67	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from fertilizer account,	2,730 00	
Cash from dairy bureau,	13 00	
Cash from farm,	1,109 45	
		$14,315 12

EXPENDED.

Cash paid salaries,	$4,879 98	
Cash paid laboratory supplies,	356 18	
Cash paid printing and office expenses,	763 41	
Cash paid farmer and farm labor,	2,430 82	
Cash paid farm supplies,	1,778 21	
Cash paid fertilizer account,	2,726 03	
Cash paid construction and repairs,	450 19	
Cash paid expense of Board of Control,	142 91	
Cash paid incidental expenses,	325 99	
Cash paid library,	208 75	
Cash on hand,	252 65	
		$14,315 12

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION (DEC. 31, 1893).

Live stock,	$527 00	
Tools, implements and machinery,	978 30	
Produce on hand,	738 59	
Fertilizers,	186 70	
Laboratory inventory,	3,526 27	
Office furniture, library, etc.,	2,138 50	
Furniture, herbariums, library and collections,	1,530 87	
Photographic supplies,	175 00	
Greenhouse apparatus,	117 50	
Mycologists' apparatus,	486 20	
Chemical apparatus and supplies,	326 85	
Buildings, land, etc.,	32,202 00	
		$42,933 78

This is to certify that I have examined the books and accounts of Charles A. Goessmann, Treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 20, 1893, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of two hundred and fifty-two and sixty-five one-hundredths dollars, which is shown to be in the bank.

WM. R. SESSIONS,
Auditor.

JAN. 10, 1894.

LIST OF EXCHANGES.

Reports and Bulletins of the United States Department of Agriculture, Washington, D. C.
Reports and Bulletins of the Agricultural Experiment Stations of the United States.
Bulletins of the State Board of Agriculture, Boston, Mass.
The American Cultivator, Boston, Mass.
The Holstein-Friesian Register, Boston, Mass.
Farm-Poultry Monthly, Boston, Mass.
Massachusetts Ploughman, Boston, Mass.
New England Farmer, Boston, Mass.
The Home and Mart, East Boston, Mass.
The American Nation, Boston, Mass.
New England Homestead, Springfield, Mass.
Farm Folks, Springfield, Mass.
Mirror and Farmer, Manchester, N. H.
New York Weekly World, New York, N. Y.
German Agricultural and Horticultural Journal (German), New York, N. Y.
American Agriculturist, New York, N. Y.
The Florists' Exchange, New York, N. Y.
Vick's Magazine, Rochester, N. Y.
The American Analyst, New York, N. Y.
Naturalist Monthly Bulletin, Philadelphia, Pa.
The Practical Farmer, Philadelphia, Pa.
The Farm Journal, Philadelphia, Pa.
The National Stockman and Farmer, Pittsburg, Pa.
Journal of the American Philosophical Society, Philadelphia, Pa.
Contributions from the Botanical Laboratory of the University of Pennsylvania, Philadelphia, Pa.
Veterinary Magazine, Philadelphia, Pa.
Maryland Farmer, Baltimore, Md.
Baltimore Weekly Sun, Baltimore, Md.
Creamery and Dairy, Waterloo, Iowa.
The Agricultural Epitomist, Indianapolis, Ind.
The New Agricultural Era, Indianapolis, Ind.
The Clover Leaf, South Bend, Ind.
The Orange Judd Farmer, Chicago, Ill.
The Western Swineherd, Geneseo, Ill.

The Dairy Messenger, Chicago, Ill.
The Dairy World, Chicago, Ill.
German Agricultural and Horticultural Journal, Chicago, Ill.
Detroit Free Press (weekly), Detroit, Mich.
University Record, Ann Arbor, Mich.
Farmers' Home Weekly, Dayton, Ohio.
American Grange Bulletin, Cincinnati, Ohio.
Journal of the Columbus Horticultural Society, Columbus, Ohio.
The Louisiana Planter, New Orleans, La.
Hoard's Dairyman, Fort Atkinson, Wis.
The Wisconsin Farmer, Madison, Wis.
The Weekly Journal, Sioux City, Iowa.
Hospoda (Bohemian Journal), Omaha, Neb.
The Industrialist, Manhattan, Kan.
The Home and Farm, Louisville, Ky.
The Industrial American, Lexington, Ky.
Journal of the Elisha Mitchell Scientific Society, Chapel Hill, N. C.
Southern Cultivator, Atlanta, Ga.
Monthly Florida Bulletin, Tallahassee, Fla.
West American Scientist, Los Angeles, Cal.
California Cultivator and Poultry Keeper, Los Angeles, Cal.
Journal of the Geographical Society of California, San Francisco, Cal.
Publications of the Department of Agriculture, Quebec, Canada.
The Journal of Agriculture, Montreal, Canada.
Bulletins of the Central Experiment Farm, Ottawa, Canada.
Industrial Journal of Agriculture, Montreal, Canada.
Agricultural Students Gazette, Cirencester, England.
Berichte der Landwirtschaftliche Verssuchstation, Halle, Germany.
Bulletins Ministere de l'Agriculture, Paris, France.
Bulletins of the College of Agriculture, Tokio, Japan.
Bulletins of the Department of Agriculture, New South Wales, Australia.
Agricultural Gazette, New South Wales, Australia.
Bulletins of the Department of Agriculture, Brisbane, Queensland, Australia.
Garden and Field Journal, South Australia.
Journal of the Council of Agriculture, Hobart, Tasmania.
Relatorio Annual da Estacao Agronomica de Campinas, Sao Paulo, Brazil.
Ragguagli, Laboratorio Chimico Agrario di Bologna, Bologna, Italy.
Reglamento, etc., Estacion Agronomica del Instituto Agricolo de Alfonso XII., Madrid, Spain.

INDEX

TO ELEVENTH ANNUAL REPORT, 1893.

PUBLIC DOCUMENT . . . . No. 33.

TWELFTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE AGRICULTURAL EXPERIMENT STATION

AT

AMHERST, MASS.

1894.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1895.

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WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 Post Office Square.
1895.

Commonwealth of Massachusetts.

Boston, Jan. 10, 1895.

To the Honorable Senate and House of Representatives.

In accordance with chapter 212 of the Acts of 1882 I have the honor to present the Twelfth Annual Report of the Board of Control of the State Agricultural Experiment Station.

WM. R. SESSIONS,

Secretary.

MASSACHUSETTS STATE
AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

STATION STAFF.

C. A. Goessmann, Ph.D., LL.D., *Director and Chemist*, . . Amherst.
J. B. Lindsey, Ph.D., *Associate Chemist (Feeding Department)*, . Amherst.

Assistants.

C. S. Crocker, B.S., .	*General and Analytical Chemistry.*
H. D. Haskins, B.S., .	" " "
C. H. Jones, B.S., .	" " "
F. L. Arnold, B.S., .	" " "
C. H. Johnson, B.S., .	" " "
E. B. Holland, B.S., .	*Assistant Chemist in Feeding Experiments.*
R. H. Smith, B.S., .	" " " "
L. E. Goessmann,* . .	*Assistant Chemist and Clerk.*
David Wentzell, . .	*Farmer.*

* Resigned July 1, 1894.

TWELFTH ANNUAL REPORT OF THE DIRECTOR

OF THE

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN: — The different lines of investigation decided upon in preceding years have been pursued during the past year. No material changes have been introduced in regard to the general character of the work assigned. The different plans for the experiments presented from time to time at the quarterly meetings for your endorsement have been carried out as far as practicable to the full extent of the means at hand. The results obtained in this connection compare well with those of preceding years. The advanced stage of some of the experiments imparts to the results obtained for obvious reasons from year to year an increased interest, and may claim for our reports a due consideration on the part of our farming community as well as students of agricultural progress in general.

The feeding experiments with different kinds of farm live stock, inaugurated soon after the establishment of the Experiment Station, have received ever since most careful attention. The inquiries into the economy of substituting several reputed forage crops, new to our section of the country, for meadow hay in the daily diet of milch cows, have been continued during the past year with much success. Several new kinds of waste products of corn (maize) and other grains have been tested with reference to their degree of fitness to serve as ingredients in efficient grain rations for different kinds of farm live stock. Much work has been accomplished in connection with the use of the Babcock apparatus for the determination of fat in milk and cream.

The question of using skim milk supplemented in various ways for the production of veal has been studied in a series of experiments with calves.

The digestion experiments with sheep, for the purpose of ascertaining the rate of digestibility of the various food constituents of some new coarse and fine feed stuffs peculiar to our markets, have been materially increased in number. The detailed record of these and other observations of interest in this connection, which have been under the special supervision of Dr. J. B. Lindsey, associate chemist of the Experiment Station, furnishes the first part of the accompanying annual report, under the following headings: —

PART I.

FEEDING EXPERIMENTS.

I. A practical talk about feeding.
II. Objects of the different experiments.
III. Feeding experiments with milch cows (two).
IV. Hay substitutes.
V. The Babcock *v.* the space system, etc.
VI. Feeding experiment with steers.
VII. Feeding calves for veal.
VIII. Digestion experiments.
  1. Digestion experiments with sheep.
  2. The digestibility of the pentosans.

The experiments in the field and in the vegetation house have been quite numerous and of a varying character. Some of them are a continuation of those of former years, while others are new. Much attention has been devoted to the raising of nutritious forage crops fit for green fodder, hay and ensilage; the results are gratifying, and cannot fail to exert a desirable influence on the future supply of coarse fodder for farm live stock, as far as quantity as well as cost of production and valuable composition is concerned. The good success noticed in the field during the first part of the summer season was in some instances seriously checked by a severe drought during the month of August. A description of the different experiments carried on in this connection by the writer forms the second part of the succeeding annual report, under the following-named headings: —

Part II.

Field Experiments.

1. Field experiments for the purpose of studying the economy of raising leguminous plants (clover, etc.) as a means of enriching the soil in nitrogen in the interest of the subsequent raising of grain crops (Field A).
2. Field experiments with several prominent varieties of potatoes and some prominent mixed forage crops (Field B).
3. Field experiments to ascertain the influence of different mixtures of commercial fertilizers on the yield and general character of several prominent garden crops (Field C).
4. Experiments with forage crops (27), to study their fitness for our climate (Field D).
5. Trial of an early maturing variety of Minnesota dent corn (Field E).
6. Field experiments with different commercial phosphates, to study the economy of using the cheaper natural phosphates or the more costly acidulated phosphates (Field F).
7. Experiments with forage crops (vetch and oats and Hungarian grass, Field G).
8. Field experiments to study the effect of phosphatic slag and nitrate of soda as compared with ground bone on the yield of oats and corn (east field).
9. Experiments with permanent grass lands (meadows).
10. Orchard. Experiments with home-made stable manure, unleached wood ashes and several mixtures of fertilizing materials on the growth and yield of several varieties of fruit trees.
11. Observations in the vegetation house.
12. Report on general farm work.

The work in the chemical laboratory of the station is steadily increasing. The progress of the work in the field, the barn and the vegetation house in some cases calls for much analytical chemical work, and the applications of the citizens of the State for free analyses of fodders, fertilizers, well water and a variety of waste products are from year to year more numerous. The amount and character of the

work in the chemical laboratory may be judged from the following statement, which represents the third part of the report: —

Part III.

Special Work in the Chemical Laboratory.

I. Communication on commercial fertilizers: —

1. General introduction.
2. State laws for the regulation of the trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1894, to May 1, 1895 (58).
4. Analyses of licensed fertilizers (253).
5. Analyses of commercial fertilizers and manurial substances sent on for examination (145).
6. Miscellaneous analyses (4).
7. Miscellaneous fodder analyses (69).

The chemical analyses made in connection with investigations carried on at the station are reported in the description of the work.

II. Analyses of milk sent on for examination (40).

III. Analyses of water sent on for examination (200).

IV. Compilation of analyses made at Amherst, Mass., of agricultural chemicals and refuse substances used for fertilizing purposes.

V. Compilation of analyses made at Amherst, Mass., of fodder articles, fruits, sugar-producing plants, dairy products, etc.

VI. Table of digestibility of American feed stuffs.

The weather observations for local purposes have been continued, and copies of our records have been regularly sent to the United States department, according to directions. The periodically published bulletins have been as many as in previous years. The number of regular applicants for copies is increasing. The supply of copies of previous years is in many cases exhausted.

The condition of the buildings pointed out in my preceding report has not been changed; some of the farm buildings need repairing of roofs and repainting. The laboratory

buildings (brick) are in a fair condition; their outfit has not been materially increased, for economical reasons.

In concluding, it gives me particular pleasure to acknowledge the satisfactory assistance I have enjoyed from all parties associated with me in carrying out the work assigned. Thanking you for the kind consideration received in the past, I am,

Yours very respectfully,

C. A. GOESSMANN,

Director.

AMHERST, MASS., Jan. 1, 1895.

ANNUAL REPORT OF C. A. GOESSMANN,

TREASURER OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION,

For the Year ending Dec. 20, 1894.

RECEIVED.		
Cash on hand from last year,	$252 65	
Cash from State Treasurer, appropriation,	10,000 00	
Cash from fertilizer account,	3,090 00	
Cash from dairy bureau,	11 00	
Cash from farm,	1,153 42	
Cash from miscellaneous sources,	79 95	
		$14,587 02
EXPENDED.		
Cash paid salaries,	$4,287 18	
Cash paid laboratory supplies,	660 79	
Cash paid printing and office expenses,	887 63	
Cash paid farmer and farm labor,	2,379 84	
Cash paid farm supplies,	1,764 24	
Cash paid fertilizer account,	3,090 00	
Cash paid construction and repairs,	544 50	
Cash paid expense of Board of Control,	90 54	
Cash paid incidental expenses,	382 92	
Cash paid library,	277 84	
Cash on hand,	221 54	
		$14,587 02

SUMMARY OF THE PROPERTY OF THE MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION (DEC. 20, 1894).

Live stock,	$645 00	
Tools, implements and machinery,	843 90	
Produce on hand,	364 00	
Fertilizers,	196 00	
Laboratory inventory,	3,500 00	
Office furniture, library, etc.,	2,095 00	
Furniture, herbariums, library and collections,	1,300 00	
Photographic supplies,	150 00	
Greenhouse apparatus,	200 00	
Mycologists' apparatus,	350 00	
Chemical apparatus and supplies,	300 00	
Buildings, land, etc.,	30,570 00	
		$40,513 90

This is to certify that I have examined the books and accounts of Charles A. Goessmann, treasurer of the Massachusetts Agricultural Experiment Station, for the fiscal year ending Dec. 20, 1894, and find them correct, and all disbursements properly vouched for, with a balance in the treasury of two hundred and twenty-one fifty-four one-hundredths dollars, which is shown to be in the bank.

WM. R. SESSIONS,
Auditor.

JAN. 15, 1895.

PART I.

FEEDING EXPERIMENTS

AND

DAIRY STUDIES.

BY J. B. LINDSEY.

I.

1. A BRIEF PRACTICAL TALK ABOUT SOME OF THE PRINCIPLES INVOLVED IN FEEDING OUR FARM ANIMALS.

In order to feed the live stock of the farm to the best advantage, it is important that the farmer be familiar with the elementary principles of animal nutrition.

Now the body of the animal is made up, generally speaking, of four distinct groups of substances, namely, (1) water, (2) flesh (lean meat), (3) fat, (4) ash.

The percentage of water in different animals in different stages of growth varies in round numbers from 40 to 85 per cent.; the percentage of bone framework of the body from 6 to 12 per cent.; the flesh, not including blood and entrails, composes from 30 to 48 per cent.; while the fat varies from 5 to 40 per cent.

An average composition of the various farm animals would be somewhat as follows: bones, 8.9 per cent.; flesh and teeth, 40.1 per cent.; fat that can be removed by mechanical means, 23.9 per cent.; and blood, hair, horns, entrails, including foods contained therein, 27.1 per cent.

The milk, an animal product, contains approximately 87 per cent. of water, 3.5 per cent. of casein and albumen or nitrogenous matter, of which the lean meat of the animal is also a type, 0.7 per cent. of ash and about 8.5 per cent. of fat and milk sugar.

The flesh or lean meat is composed of nitrogen, carbon, hydrogen, oxygen, sulphur and phosphorous; its characteristic element is the nitrogen. Small quantities of ash also enter into its composition. The bones are made up partly of nitrogenous matter, such as glue, gelatine, etc., partly of fat and partly of ash. The ash or earthy part of the bone,

as some call it, is composed principally of phosphate of lime. The fat contains no nitrogen, but has as high as 76 per cent. of carbon, the balance consisting of oxygen and hydrogen.

The ash constituents of the body consists essentially of lime, potash, soda, magnesia, iron, phosphoric acid and sulphuric acid. The phosphate of lime predominates.

Now, these various substances, making up the animal body, — flesh, fat, ash and water, — are formed or obtained direct with the aid of the oxygen of the air from the substances termed foods that the animal consumes. Our neat stock, for example, consume the various coarse fodders and grains and have the power within them of converting these vegetable foods into flesh, fat and bone.

Recognizing, then, the composition of the animal body, both as regards its groups of substances and the more elementary substances that make up these groups, let us turn our attention to a brief study of the foods from which the body is built up.

Classification and Composition of Cattle Foods.

(*a*) *Classification.*

For our purpose cattle foods may divide into: (1) coarse fodders, (*a*) those rich in carbohydrates (cellular matter, starch, etc.) and low in protein, and about 50 to 65 per cent. digestible, (*b*) the legumes when cut in bloom, rich in protein and about as digestible as (*a*); (2) root crops, also rich in carbohydrates and low in protein, but very digestible; (3) concentrated foods with a digestibility of from 75 to 85 per cent. The concentrated foods should be subdivided into (*a*) those rich in carbohydrates and comparatively low in protein, such as wheat, rye, barley, oats and corn; and (*b*) those that are rich in protein and comparatively low in carbohydrates, as peas, beans, gluten feeds and meals, cotton-seed meal, linseed meals, peanut meal, etc.

Table of Classification.

Coarse Foods.		Roots.	Concentrated Foods.	
(*a*) Low in protein, high in carbohydrates; 50-65 per cent. digestible.	(*b*) High in protein, medium in carbohydrates; 50-65 per cent. digestible.	Low in protein, rich in carbohydrates; very digestible.	(*a*) Low in protein, high in carbohydrates; 75-85 per cent. digestible.	(*b*) Very high in protein, low in carbohydrates; 75-85 per cent. digestible.
Hays of various grasses, straws, corn fodder, corn straw, corn ensilage.	Clovers, peas, beans, soya bean, vetches, serradella, etc.	Mangolds, sugar beets, turnips, potatoes, carrots, etc.	Wheat, rye, barley, oats, corn.	Pea and bean meal, gluten feeds and meals, cottonseed meal, linseed meals, peanut meals, etc.

(*b*) *Composition.*

All of our cattle foods have been divided into five groups of substances: (1) crude ash, (2) crude cellulose, (3) crude fat, (4) crude protein, (5) extract matter. Water is always present, and might be called a sixth group.

Each one of the first five groups can be resolved into more simple substances. With some of the substances or compounds making up the groups we have only a partial knowledge.

(*1*) *Crude Ash.*

By crude ash is meant the mineral ingredients of the plant or seed remaining behind after the organic portion has been destroyed by fire. The ash or ashes of a plant consist essentially of lime, potash, soda, magnesia, iron, phosphoric acid, sulphuric acid, etc.

Functions of the Ash. — It is these various mineral ingredients that serve to build up the bony structure of the animal; they also enter into and are necessary components of the flesh itself.

(*2*) *Crude Cellulose.*

The crude cellulose is the coarse or woody part of the plant; we may term it the framework of the plant. Its elementary composition is carbon, oxygen, hydrogen and a small percentage of ash. The crude cellulose is largely present in straws and hays; the various grains, on the other

hand, contain but a small percentage. Cows, oxen, sheep and horses have a digestive tract so arranged as to be able to consume and digest large quantities of such coarse fodders.

Functions of the Cellulose. — It cannot form flesh, but serves to produce vital energy and fat.

(3) *Crude Fat.*

By crude fat is meant not only the fats and oils found in the various foods, but also the waxes, resins, etc. It has also been termed "ether extract," because it is that portion of the plant soluble in ether. Its elementary composition is carbon, oxygen and hydrogen, with a much higher percentage of carbon than either the cellulose or extract matter.

Functions of the Fat. — It serves the same purposes as the cellulose; it furnishes, however, two and one-half times as much heat or energy as the cellulose.

(4) *Crude Protein.*

Protein is a general name for all the nitrogen-containing bodies found in our common agricultural plants. It might be called "vegetable meat." It corresponds, generally speaking, to the lean meat of the animal body. All protein or albuminoids contain on an average about 16.5 per cent. of nitrogen. It is, other things being equal, the most valuable food constituent of the plant. Its elementary composition is carbon, nitrogen, oxygen, hydrogen, phosphorus and sulphur.

Functions of the Protein. — The protein is a source of energy, and is *the only source of flesh.* It also has been considered a source of fat, although much doubt has lately been thrown upon this idea.

(5) *Extract Matter.*

The so-called non-nitrogenous extract matter consists of the starch, sugars and gums. A large part of the extract matter of the coarse fodders (one-third to one-half) consists of the wood gums or pentosans. It has been shown that in the majority of cases the pentosans are as valuable for food

as other carbohydrates. The elementary composition of the extract matter is carbon, oxygen and hydrogen.

Functions of the Extract Matter. — The sugars, starch and gums furnish energy, and serve as sources of fat. The crude cellulose and the extract matter, having the same functions in the animal economy, namely, the production of energy and fat, have been termed carbohydrates. The ash, while a necessary ingredient of all complete foods for live stock, is not generally considered in compounding suitable daily diets for our farm animals; so that, for practical purposes, we really have to do with but three groups: (1) protein, (2) carbohydrates, (3) fat.

Having noted the different groups of substances of which our agricultural plants are composed, let us briefly turn our attention to the value of these groups as sources of nourishment. No one of them is of itself a suitable food for our farm animals, nor will any one of them sustain life for any length of time.

Digestibility of Cattle Foods.

Foods are valuable as sources of nourishment only in so far as their various constituents or groups can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having more digestible matter, would prove the more valuable fodder. In order to combine the various fodders into what has been termed a fodder ration, it is important to know how large a part or per cent. of the various groups is digestible. A great many digestion experiments have been made with various cattle foods, especially in Germany; during the last six or seven years a considerable number have been carried out in the United States. A tabulated list of all American experiments will be found at the end of this report.

How the Digestible Matter of a Food is determined.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion

excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

A Single Illustration, showing how the Digestibility of a Fodder is determined.

[Solid manure equals the undigested part of food.]

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams)
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.09
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

Having noted the various groups of substances going to make up our cattle foods, and recognizing that these groups are valuable as sources of nourishment only in so far as they are digestible, let us next inquire into the *proper way of combining these foods*, so as to produce properly balanced daily diets or

Fodder Rations for the Animals of the Farm.

A great many experiments have been made in order to study the behavior of the protein, carbohydrates and fat in the animal body, and their specific influences upon the formation of flesh, fat and milk. We will not attempt in this connection to give in detail the results of these studies, but simply state that they have led to the combining of our coarse and concentrated foods in such a way as to obtain in the daily diet of the animal the digestible protein, fat and carbohydrates in certain reasonably definite proportions.

The German investigator Wolff, who has made a close study of all experiments along this line, has concluded that a milch cow, for example, in order to produce a large and well-sustained yield of milk, should be fed about 2.5 pounds

of digestible protein, .5 pound of digestible fat and 13 pounds of digestible carbohydrates daily, on the basis of 1,000 pounds live weight. In preparing fodder rations for milch cows, then, it should be our aim to so combine the coarse and concentrated foods as to obtain these groups in the approximately correct proportions. Variety and palatability of food must also be taken into consideration.

How Fodder Rations are made up.

In order to show how fodder rations are put together, we will construct one from English hay, corn meal, cotton-seed meal and wheat bran. We must know (1) the analyses of the fodders and (2) their digestibility. These data are to be found in the table following: —

Table showing Composition and Digestibility.

	English Hay.		Corn Meal.		Cotton-seed Meal.		Wheat Bran.	
	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.	Composition.	Per Cent. Digestible.
Moisture,	15.00	-	14.00	-	7.00	-	10.00	-
Dry matter,	85.00	-	86.00	-	93.00	-	90.00	-
	100.00	-	100.00	-	100.00	-	100.00	-
Dry matter contains: —								
Crude ash,	6.20	notdet.	1.62	notdet.	7.30	notdet.	7.50	notdet.
" cellulose,	31.00	60	2.15	77	7.70	-	11.00	25
" fat,	2.80	49	3.83	85	12.00	97	5.00	72
" protein,	10.00	60	11.00	72	44.00	88	18.00	78
Extract matter,	50.00	60	81.40	94	29.00	64	58.50	68
	100.00	-	100 00	-	100.00	-	100.00	-

The average composition and the average per cent. digestible of all cattle foods are to be found in tables at the end of this report.

Rules for compounding Properly Balanced Fodder Rations.

1. A milch cow of 1,000 pounds live weight needs approximately 2.5 pounds of digestible protein, .5 to .75 pound of digestible fat and 13 pounds of digestible carbohydrates daily.

2. Calculate the rations on the basis of 1,000 pounds live weight. Cows weighing but 700 to 800 pounds will need only seven-tenths or eight-tenths as much. (This is not always true. Example: very thin cows fresh in milk would need rather more, and cows in fair to good condition towards the end of lactation less.)

3. Use 21 pounds of English hay or its equivalent of some other coarse fodder as a basis. (This will furnish 1 pound of digestible protein, and it is now necessary to make up the necessary amount of protein by the addition of concentrated fodders. In doing this the necessary carbohydrates not furnished by the hay will also be added.)

4. Use 8 to 10 pounds of two or three different grains, about one-third of each kind. (Not over 3 pounds of corn meal should be added. The various gluten feeds can often take the place of corn meal to advantage. It is almost always economical to use 3 pounds of bran. As the third grain 2 to 3 pounds of one very high in protein should be used, such as cotton-seed meal, or one of the gluten or linseed meals.)

5. Reduce the quantity of each of the substances to be fed *to dry matter*, by multiplying by the *average per cent. of dry matter* in such substances, as found in the tables.

6. Multiply the amount of dry matter in each of the foods by the average percentages of cellulose, fat, protein and extract matter it contains, and these products by the *digestion percentages* of these same groups. The last products will be the amount of digestible cellulose, fat, protein and extract matter contained in each of the several foods. Add the several digestible amounts as found in the various foods together, and the sum will be the total digestible cellulose, fat, protein and extract matter in all of the feeds going to make up the daily ration.

7. To calculate the nutritive ratio of the ration, multiply the amount of digestible fat by $2\frac{1}{2}$, and add the product to the digestible cellulose and extract matter; divide this sum by the digestible protein, and the dividend will be the ratio required.

A Practical Example.

Fodder Ration for a Milch Cow of 1,000 Pounds Live Weight.

	Digestible.			
	Protein.	Fat.	Carbohydrates.	Total.
	Pounds.	Pounds.	Pounds.	Pounds.
Needed, ...	2.50	0.50	13.00	16.00

Ration shall be composed of: —

21 pounds English hay.
3 pounds corn meal.
3 pounds cotton-seed meal.
3 pounds wheat bran.

	Fodders.			Fodder Constituents.			
	Pounds as Fed.	Per Cent. Dry Matter therein.	Pounds Dry Matter.	Per Cent	Pounds.	Per Cent. Digestible.	Pounds Digestible.
				(a) Cellulose.			
Hay, ...	21×	85=	17.85×	31.00=	5.53×	60=	3.31
Corn meal, ...	3×	86=	2.60×	2.15=	0.06×	77=	0.05
Cotton-seed meal, ...	3×	93=	2.80×	7.70=	0.22×	00=	0.00
Wheat bran, ...	3×	90=	2.70×	11.00=	0.30×	25=	0.07
Total, ...	.	.	. .	. .	. .	.	3.43
				(b) Fat.			
Hay, ...	21×	85=	17.85×	2.80=	0.50×	49=	0.25
Corn meal, ...	3×	86=	2.60×	3.83=	0.10×	89=	0.09
Cotton-seed meal, ...	3×	93=	2.80×	12.00=	0.34×	88=	0.30
Wheat bran, ...	3×	90=	2.70×	5.00=	0.13×	72=	0.09
Total, ...	.	.	. .	. .	. .	.	0.73
				(c) Protein.			
Hay, ...	21×	85=	17.85×	10.00=	1.78×	60=	1.07
Corn meal, ...	3×	86=	2.60×	11.00=	0.29×	72=	0.21
Cotton-seed meal, ...	3×	93=	2.80×	44.00=	1.23×	85=	1.04
Wheat bran, ...	3×	90=	2.70×	18.00=	0.49×	78=	0.38
Total, ...	.	.	.	. .	. .	.	2.70
				(d) Extract Matter.			
Hay, ...	21×	85=	17.85×	50.00=	8.92×	60=	5.35
Corn meal, ...	3×	86=	2.60×	81.40=	2.11×	94=	1.98
Cotton-seed meal, ...	3×	93=	2.80×	29.00=	0.81×	95=	0.77
Wheat bran, ...	3×	90=	2.70×	58.50=	1.58×	68=	1.07
Total, ...	.	.	. .	. .	. .	.	9.17

Summary.

	Pounds.
Total digestible protein,	2.70
Total digestible fat,	0.73
Total digestible cellulose and extract (carbohydrates),	12.60
Total digestible organic nutrients,	16.03

These figures correspond very closely with the amounts required (see top of page 22).

Calculating the Nutritive Ratio.

	Pounds.
Carbohydrates,	12.60
Fat, .73 pound $\times 2\frac{1}{4} =$	1.82
Total,	14.42

14.42 pounds carbohydrates ÷ 2.7 pounds protein = 5.34, or as 1 protein is to 5.34 carbohydrates (1 : 5.34).

The Real Meaning of Nutritive Ratio.

Nutritive ratio is simply the numerical relation which the fat and carbohydrates bear to the protein which is taken as unity; or, stated in the form of a problem, how many more units of carbohydrates and fat reduced to carbohydrates are present in the ration than units of protein?

It has been demonstrated by experiment that, other things being equal, the best returns can be secured in case of milch cows, for example, if the various fodders are so combined as to produce a ration containing 4.5 to 5.5 times as much carbohydrates as protein; or, in other words, rations having a nutritive ratio of 1 : 4.5 to 5.5.

While this proportion should be kept in mind in making up the fodder ration, palatability and variety should by no means be lost sight of.

Rations with a nutritive ratio of 1 : 4.5 to 6 are termed narrow rations; those with ratios of 1 : 6 to 1 : 10, wide rations.

2. SOME GOOD FODDER RATIONS FOR FARM ANIMALS.

I. Milch Cows and Growing Neat Stock.

These animals should have 16 pounds of digestible organic nutrients daily divided into: digestible protein, 2.50 to 3.00 pounds; digestible fat, .50 to 1.00 pounds; digestible carbohydrates, 12 to 13 pounds; on the basis of 1,000 pounds live weight. These various ingredients will be found in the correct proportions in the following combinations: —

I. Basal Rations.

(*a*)
English hay,* 18 pounds.
Roots, . . 15 pounds.

(*b*)
English hay, 21 pounds.

(*c*)
English hay, . 4 pounds.
Corn stover, . 4 pounds.
Corn ensilage, 40 pounds.

(*d*)
Hay, . . 5 pounds.
Dry corn fodder, 25 pounds.

(*e*)
Hay of vetch and oats, 10 pounds.
English hay, 5 pounds.
Corn stover, 6 pounds.

(*f*)
Green crops,† 50–70 pounds.

These coarse fodders for practical purposes can generally be fed *ad libitum; i. e.*, the animals can be given all they will consume. There are, of course, some exceptions, but the practised eye of the feeder will control such cases.

II. Grain Rations.

The following grain rations are combined to go with the above coarse fodders. These should always be weighed or measured out: —

* The many experiments at this station have shown that hay is too costly to be fed in large quantities to cows and growing stock. Its place should be taken by other coarse fodders.

† In case green leguminous crops are fed, only one-half to one-third of the grain ration that follows need be given.

(*a*)

Cotton-seed meal,	100 pounds.	
Wheat bran,	100	"
Corn meal,*	100	"

Mix and feed 9 quarts daily.

(*b*)

Chicago gluten meal,	100 pounds.	
Wheat bran,	100	"
Gluten feed,*	100	"

Mix and feed 9 quarts daily.

(*c*)

Linseed meal,†	100 pounds.	
Wheat bran,	100	"
Ground wheat,	100	"

Mix and feed 9 quarts daily.

(*d*)

Linseed meal,†	100 pounds.	
Pope or King gluten meal,	100	"
Wheat bran,	200	"

Mix and feed 9 quarts daily.

The maize or gluten feeds can be used interchangeably one for the other; the linseed meal and Chicago gluten meal can also be substituted one for the other. Cotton-seed meal, King gluten meal and Pope gluten meal should not be combined (especially in summer) with other concentrated foods rich in fat, and it is better to feed but one of these in any daily grain ration. To be on the safe side, we would not advocate more than 2 or at the utmost 3 quarts of these feeds daily.

In making up the grain rations, cost must be considered, and farmers will have to use judgment in this respect. Thus, if cotton-seed meal costs $24 per ton and Chicago gluten meal $26, the cotton-seed meal would be much more economical.

The following figures show the approximate *relative commercial values* of the grains, figured on the basis of the amount of digestible protein they contain. By this is meant that if corn meal was worth $21 per ton Chicago gluten meal would be worth $28, etc. This does *not* mean that these two grains, side by side, would have the same feeding effect, but the figures are presented as a basis to be used in purchasing: —

	Per Ton.
Corn meal,	$21 00
Wheat brans,	18 00
Gluten feeds,	23 00
Gluten meals,	28 00
Cotton-seed meal,	30 50
New-process linseed meal,	29 00
Old-process linseed meal,	28 25

* Three quarts of either Buffalo gluten feed, Peoria gluten feed or Chicago maize feed can be substituted with good effect for the corn meal.

† Old or new process.

II. Winter Fodder Rations for Growing Lambs (60 to 100 Pounds).

The following combinations of grains and coarse fodder have proved valuable as winter fodder rations for lambs (yearlings).

In general, where corn ensilage has been substituted for one-half to two-thirds of the rowen the growth has been fully as good and the cost of production of live weight somewhat less.

I.		II.	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Chicago gluten meal,	0.50 "	Chicago gluten meal,	0 50 "
Rowen,	2.00 "	Rowen,	1.00 "
Nutritive ratio,	1 : 4 50	Corn ensilage,	3.50 "
Total cost (approximate),	2.50 cts.	Nutritive ratio,	1 : 5 09
Manurial value obtainable,	1.15 "	Total cost (approximate),	2.24 cts.
Net cost,	1.36 "	Manurial value obtainable,	1.10 "
		Net cost,	1.14 "
III.		**IV.**	
Wheat bran,	0.50 lbs.	Wheat bran,	0.50 lbs.
Linseed meal,	0.25 "	Linseed meal,	0.25 "
Rowen,	1.50 "	Rowen,	0.50 "
Nutritive ratio,	1 : 4.0	Corn ensilage,	3.50 "
Total cost (approximate),	2.08 cts.	Nutritive ratio,	1 : 5.0
Manurial value obtainable,	1.02 "	Total cost (approximate),	1.8 cts.
Net cost,	1.06 "	Manurial value obtainable,	0.9 "
		Net cost,	0.9 "
V.		**VI.**	
Corn meal,	0.50 lbs.	Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0 50 "	Rowen,	2.00 lbs.
Rowen,	1.50 "	Nutritive ratio,	1 : 5.3
Nutritive ratio,	1 : 5.3	Total cost (approximate),	2.33 cts.
Total cost (approximate),	2 40 cts.	Manurial value obtainable,	1.25 "
Manurial value obtainable,	1.30 "	Net cost,	1.07 "
Net cost,	1.10 "		

VII.

Buffalo gluten feed,	0.75 lbs.
Cotton-seed meal,	0.25 "
Rowen,	0.50 "
Corn ensilage,	4.00 "
Nutritive ratio,	1 : 4.6
Total cost (approximate),	2.04 cts.
Manurial value obtainable,	1.14 "
Net cost	0.90 "

Linseed meal, cotton-seed meal and Chicago gluten meal can be substituted one for the other without very materially changing the cost of the ration or its feeding effect. Buffalo gluten feed and Chicago maize feed can also be used interchangeably.

One-half pound of rowen and four to five pounds of corn ensilage in a ration tend to cheapen the cost and are as effective in feeding value as one and one-half to two pounds of rowen. In general, four pounds of corn ensilage can be reckoned an equivalent for one pound of rowen, so far as dry matter is concerned.

The rations as given can be increased or decreased proportionately in quantity to suit the appetite and size of the animals fed.

III. Practical Rations for Pig Feeding.

When skim-milk is used as a part of the daily diet in feeding pigs for the market, the station feels justified, in view of its feeding experiments, in recommending the following practical rations as being valuable in producing pork at a minimum cost : —

I.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80,	2 ounces corn meal to each quart milk,*	1 : 3.30
80 to 125,	4 ounces corn meal to each quart milk,	1 : 4.00
125 to 190,	6 ounces corn meal to each quart milk,	1 : 4.50

* Creamery buttermilk can be substituted for skim-milk as above with good results if it can be had at a reasonable price, say 1.4 cents per gallon.

When skim-milk is in limited supply (from four to six quarts per pig), feed as follows : —

II.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	Milk at disposal, and one part by weight wheat bran, two parts by weight gluten meal, to satisfy appetite.	1:3.20
80 to 125, .	Milk at disposal and following mixture: one weight part corn meal, one weight part wheat bran, one weight part gluten meal, to satisfy animal.	1:4.00
125 to 190, .	Milk at disposal and following mixture: two weight parts corn meal, one weight part wheat bran, one weight part gluten meal.	1:4.50

III.

Weight of Pigs (Pounds).	Food.	Nutritive Ratio.
20 to 80, .	2 ounces corn meal to each quart of milk and 4 ounces gluten feed as a substitute for each quart milk.	1:3.25 to 4.00
80 to 125, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one part by weight corn meal.	1:4.00 to 4.40
125 to 190, .	6 quarts skim-milk and a mixture of one part by weight gluten feed and one and one-half parts by weight corn meal.	1:4.4 to 4.9

IV. Rations for Farm Horses.

While we have never carried out any direct experiments with horses, the following rations, fed to our farm horses, have given very excellent results (basis 1,000 pounds live weight): —

(*a*) *Light Work* (*Winter*).

	Pounds.
Hay, ...	15
Wheat bran, ...	2
Provender, ...	4

(*b*) *Medium Work*.

	Pounds.
Hay, ...	15
Wheat bran, ...	3
Provender, ...	6

(c) *Hard Work.*

	Pounds.
Hay, ...	15
Wheat bran, ...	4
Provender, ...	8

The provender consists of cracked corn and oats, in the proportion of 400 pounds of the former to 15 bushels of the latter.

The following table shows the pounds of digestible nutrients in our ration for medium work, as compared with Wolff's for horses of 1,000 pounds live weight, doing medium work and hard work: —

	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbo-hydrates (Pounds).	Total Digestible Matter (Pounds).	Nutritive Ratio.
Medium work, . . .	1.58	0.43	11.25	13.26	1 : 7.81
Wolff's standard, medium work, ...	1.55	0.55	10.85	12.95	1 : 7.80
Wolff's standard, hard work, .	2.12	0.83	12.63	15.58	1 : 7.00

II.

OBJECTS OF THE FOLLOWING EXPERIMENTS.

III. Feeding Experiments with Milch Cows.

1. October to December, 1893.

To note the comparative feeding effects of English hay, hay of vetch and oats and soja bean and barley straw upon the production and cost of milk.

Grain feed was constant, and consisted of wheat bran, Buffalo gluten feed and new-process linseed meal.

2. January to May, 1894.

(*a*) To determine how much digestible protein can be economically fed to milch cows.

(*b*) To determine the effect of different quantities of protein upon the quantity and quality of the milk.

3. Creamery Record of the Station.

The tabulated results of the station herd for 1893 and 1894.

IV. Hay Substitutes.

A résumé of some experiments with vetch and oats and peas and oats, calling attention to their value for milk production, as compared with English hay.

V. The Babcock *v.* the Space System as a Basis for Payment in Massachusetts Creameries.

The object of this experiment is to call attention to the composition of cream from various patrons raised by the deep-setting process, in order to see if the payment for cream by the space (or fraction of an inch) is equally just to all parties. The Babcock method is contrasted with the space system.

VI. Feeding Experiments with Steers.

(*a*) To note the effect of distinct fodder rations upon the production of live weight.

(*b*) To secure facts relative to the actual cost of beef production in Massachusetts under existing local conditions.

(*c*) To compare the relative merits and cost of pasture *v.* soiling during the summer season. (A résumé of all our experiments with steers follows this experiment.)

VII. Feeding Calves for Veal.

(*a*) To see if it were possible to replace the butter fat removed in the cream by some cheaper fat or oil, thus producing a mixture resembling in composition whole milk.

(*b*) To see if such a mixture would fatten calves economically.

VIII. Digestion Experiments with Sheep.

1. To study the digestibility and consequent value as a source of food of a variety of concentrated cattle foods.

2. The digestibility of the pentosans. An investigation into the value as a source of food of a group of substances, called pentosans, found in most of our cattle foods, concerning which our knowledge heretofore has been very limited. This article at the present time has rather more of a scientific than practical interest.

III.

FEEDING EXPERIMENTS WITH MILCH COWS.

1. COMPARATIVE VALUE OF DIFFERENT COARSE FEEDS.

By J. B. Lindsey.

October–December, 1893.

[Grains fed: wheat bran, Buffalo gluten feed, new-process linseed meal. Coarse feeds: hay, dry vetch and oats, soja-bean hay and barley straw.]

Object of the Experiment.

To note the comparative effect of English hay, dry vetch and oats, soja-bean hay and barley straw upon the production and cost of milk.

Results of the Experiment.

The average cost of producing milk from six cows of the station herd in different periods of lactation was 2.3 cents per quart; the average yield was 9.46 quarts per day.

Hay of vetch and oats compared very favorably with English hay for milk production.

The composition of the milk was apparently not affected by the different coarse fodders.

The Experiment.

The analyses of the foods fed and their fertilizing value, the history and feeding record of the individual cows, etc., will be found at the end of the experiment.

Six cows were used in the trial; they were grades of various breeds in different periods of lactation, yielding from 7 to 15 quarts of milk daily.

The fodder articles were all in good condition, and may be considered fair samples of their kind.

During the entire feeding trial the grain ration remained constant, the coarse fodders alone being changed. The cows were fed, watered and milked twice daily, one-half the food being given at each feeding. They were allowed out-door exercise on every pleasant day. They were weighed once a week, after the morning's feeding and milking but before being watered.

A composite sample of the milk was taken three days of each week during the trial, thus furnishing the average of every six milkings out of fourteen. This at least gives a good average for each week.

Average Composition of the Daily Fodder Rations (1893–94).

I.		II.	
October 5 to October 16.		*October 25 to November 27.*	
Wheat bran,	3.00 lbs.	Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "	Buffalo gluten feed,	3.00 "
New-process linseed meal,	3.00 "	New-process linseed meal,	3.00 "
Hay,	17.63 "	Hay of vetch and oats,	16.52 "
Nutritive ratio,	1 : 4.40	Nutritive ratio,	1 : 4.20
Total cost,	22.97 cts.	Total cost,	22.14 cts.
Manurial value obtainable,	10 85 "	Manurial value obtainable,	11 28 "
Net cost,	12.12 "	Net cost,	10.86 "

III.

December 9 to January 2.	
Wheat bran,	3.00 lbs.
Buffalo gluten feed,	3.00 "
New-process linseed meal,	3.00 "
Soja-bean hay,	10.81 "
Barley straw,	4.56 "
Nutritive ratio,	1 : 4.13
Total cost,	20.14 cts.
Manurial value obtainable,	10.79 "
Net cost,	9.35 "

Three pounds wheat bran equal 4 quarts; 3 pounds Buffalo gluten feed equal 3 quarts; 3 pounds new-process linseed meal equal 2½ quarts.

The *total cost* of a fodder ration is the sum of the market costs of the different articles consumed per day. The *manurial value obtainable* is the value of the nitrogen, phos-

phoric acid and potash of the ration fed that will be found in the manure. In case of milch cows this amounts on an average to 80 per cent. of the fertilizing ingredients contained in the feed. The other 20 per cent. goes into the milk or flesh of the animal. The value of the nitrogen, phosphoric acid and potash thus excreted is based upon the retail cost of these articles in the open markets. When the experiment was in operation this amounted to 15 cents per pound for nitrogen, 5½ cents per pound for phosphoric acid and 4½ cents per pound for potash. The *net cost* of a ration is that cost remaining after the value of the manure has been deducted from the total cost.

Quantity and Cost of Milk produced Daily.

Feeding Periods.	Nettie.		Jennie.		Gem.		Julia.		Nora.		Nellie.		Average.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
I., . .	14.40	1.61	6.82	3.19	8.87	2.62	8.64	2.69	8.82	2.64	13.77	1.67	10.22	2.25
II., . .	12.69	1.87	5.88	3.47	9.14	2.42	8.46	2.62	8.26	2.69	12.17	1.82	9.43	2.35
III., . .	11.24	1.81	5.11	3.72	8.85	2.36	7.53	2.80	8.10	2.44	11.54	1.71	8.73	2.31

If we notice the averages in the above table, it will be seen that the cows declined slightly and regularly in the yield of milk during the three months of trial. There was a decrease of 7.8 per cent. in the milk production between the first and second periods and a further decrease of 6.8 per cent. between the second and third periods, making a total decrease of 14.6 per cent. during the three months of trial. This is by no means excessive. Five of the six cows gave an average increase of 19 pounds each in live weight during the vetch and oats period. When it is also remembered in cases of the hay and the vetch and oats periods that the former lasted but 12 days and the latter 34 days, the difference in yield in favor of the hay would be still further reduced. The cost of feed per quart of milk is about the same in all three periods, a very slight difference in favor

of the hay period being observed, which would probably be counterbalanced when the longer vetch and oats period and the natural decline in yield are considered. The vetch and oats hay compared, then, quite well with the first cut hay of upland meadows.

While the soja-bean hay and barley straw compared very favorably with the other coarse fodders, it is hardly to be commended, because of the tendency of the bean leaves of the soja-bean plant, like all leguminous crops, to dry up and fall off in the process of curing. The soja bean can be much better preserved in the silo mixed with corn fodder.

Quality of Milk Produced.

Feeding Periods.	Rations.	Nettie.		Jennie.		Gem.		Julia.		Nora.		Nellie.	
		Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.	Total Solids.	Fat.
I. 12 days.	Grain and hay,	12.17	3.62	15.11	5.81	13.38	4.76	14.94	5.75	13.54	4.60	15.78	6.60
	Grain and hay,	12.71	3.95	15.26	5.80	13.29	4.55	14.57	5.72	13.46	4.20	13.31	4.00
	Average,	**12.44**	**3.79**	**15.19**	**5.81**	**13.34**	**4.66**	**14.76**	**5.74**	**13.50**	**4.40**	**14.55**	**5.30**
II. 34 days.	Grain and hay of vetch and oats,	12.40	3.90	16.16	6.20	13.85	4.78	13.81	4.60	13.66	4.40	14.26	5.10
	Grain and hay of vetch and oats,	12.59	3.43	16.69	6.40	14.08	5.00	13.78	3.98	12.29	2.93	13.56	3.73
	Grain and hay of vetch and oats,	12.80	3.85	16.84	6.45	13.24	4.15	14.34	4.43	13.42	3.82	13.81	3.80
	Grain and hay of vetch and oats,	13.07	3.80	15.64	5.43	13.61	4.50	14.28	4.65	13.24	3.60	13.83	3.80
	Grain and hay of vetch and oats,	13.23	3.90	15.39	5.40	13.39	4.40	14.39	5.00	13.53	4.20	14.20	4.30
	Average,	**12.82**	**3.78**	**16.14**	**5.98**	**13.63**	**4.57**	**14.12**	**4.53**	**13.23**	**3.79**	**13.93**	**4.15**
III.* 25 days.	Grain, soja-bean hay and barley straw,	12.81	3.40	15.63	5.78	13.40	4.40	14.09	4.63	13.35	3.75	13.54	3.60
	Grain, soja-bean hay and barley straw,	12.58	3.60	16.07	6.30	13.43	4.50	14.46	5.00	13.54	4.00	14.15	4.25
	Grain, soja-bean hay and barley straw,	13.16	4.30	16.05	6.30	13.25	4.40	14.32	5.00	13.10	4.05	13.94	4.30
	Average,	**12.85**	**3.77**	**15.92**	**6.13**	**13.36**	**4.43**	**14.29**	**4.88**	**13.33**	**3.93**	**13.88**	**4.05**

* In the cases of Jennie and Julia the third period lasted only 20½ days.

In case of cows Nettie, Jennie and Gem the percentage of solids and fat remained very constant during the three periods, while the solids and fat of the milk of cows Julia, Nora and Nellie show a decrease in the last two periods. This decrease can only be explained on the ground that the change of feed interfered for a time with the process of secretion. Towards the end of each period it is noted that the composition of the milk of two of three cows approached that of the first period again. Cows Nora and Nellie seemed for quite a while to produce milk of a varying fat content.

DETAILS OF THE EXPERIMENT.

FEEDING RECORD.

Nettie.

FEEDING PERIODS.	Feed consumed (Pounds) per Day. Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
1893-94.												
Oct. 5 to Oct. 16,	3.00	3.00	3.00	18.00	–	–	–	23.36	14.40	1.62	1:4.45	882
Oct. 25 to Nov. 27,	3.00	3.00	3.00	–	18.71	–	–	23.65	12.69	1.86	1:4.40	917
Dec. 9 to Jan. 2,	3.00	3.00	3.00	–	–	11.24	4.41	21.32	11.24	1.90	1:4.10	907

Jennie.

FEEDING PERIODS.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.	Dry Matter consumed per Day (Pounds).	Milk produced per Day (Quarts).	Pounds of Dry Matter per Quart of Milk.	Nutritive Ratio.	Average Weight of Animal (Pounds).
Oct. 5 to Oct. 16,	3.00	3.00	3.00	16.00	–	–	–	21.66	6.82	3.18	1:4.20	806
Oct. 25 to Nov. 27,	3.00	3.00	3.00	–	14.21	–	–	19.90	5.88	3.38	1:4.10	818
Dec. 9 to Dec. 29,*	2.78	2.78	2.78	–	–	9.43	4.29	19.70	5.11	3.86	1:4.00	831

Gem.

Oct 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	8.87	2.63	1:4.45	1,070
Oct 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.53	–	–	21.83	9.14	2.39	1: 4.20	1,087
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	11.82	4.61	22.00	8.85	2.49	1:4.20	1,080

Julia.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	8.64	2.70	1:4.45	873
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.51	–	–	21.82	8.46	2.58	1:4.20	891
Dec. 9 to Dec. 29,* . .	3.00	3.00	3.00	–	–	11.97	4.66	22.15	7.53	2.94	1:4.20	899

Nora.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	18.00	–	–	–	23.36	8.82	2.65	1:4.45	809
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.60	–	–	21.89	8.26	2.65	1:4.20	821
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	10.19	4.68	20.68	8.10	2.55	1:4.00	832

Nellie.

Oct. 5 to Oct. 16, . .	3.00	3.00	3.00	17.75	–	–	–	23.15	13.77	1.68	1:4.40	902
Oct. 25 to Nov. 27, . .	3.00	3.00	3.00	–	16.56	–	–	21.86	12.17	1.80	1:4.20	882
Dec. 9 to Jan. 2, . .	3.00	3.00	3.00	–	–	10.20	4.68	20.69	11.54	1.79	1:4.00	851

* Sold.

History of Cows.

Name of Cow.	Breed.	Age (Years).	Last Calf dropped.	Daily Yield of Milk at Beginning of Trial (Quarts).
Nettie,	Grade Holstein,	5	July 2, 1893,	15
Jennie,	Grade Jersey,	4	Dec. 25, 1892,	7
Gem,	Grade Shorthorn,	6	Dec. 6, 1891,	8–9
Julia,	Native,	9	Jan 18, 1893,	9–10
Nora,	Grade Ayrshire,	5	Mar. 25, 1893,	10
Nellie,	Native,	8	Aug. 15, 1893,	14

Local Market Cost, per Ton, of the Various Articles of Fodder Fed.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
New-process linseed meal,	27 00
Hay,	15 00
Hay of vetch and oats,	15 00
Soja-bean hay,	15 00
Barley straw,	10 00

Analyses of Fodder Articles.

Fodder Analyses.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Moisture at 100° C.,	12.42	8.30	10.62	15.00	16.67	16.21	12.80
Dry matter,	87.58	91.70	89.38	85.00	83.33	83.79	87.20
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.10	0.91	5.89	7.83	11.38	12.62	4.94
" cellulose,	11.06	7.96	8.84	32.74	30.15	27.73	39.84
" fat,	6.10	14.25	3.94	3.08	3.45	2.55	2.49
" protein,	18.29	22.48	40.79	10.79	13.51	14.89	6.21
Nitrogen-free extract,	58.45	54.40	40.54	45.56	41.51	42.21	46.52
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Digestion Coefficients.

	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Crude cellulose,	25	43	61	60	66	58	56
" fat,	72	81	91	49	19	14	42
" protein,	78	85	87	60	60	64	20
Nitrogen-free extract,	68	81	86	60	54	61	54

Fertilizing Constituents.

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5½ cents, per pound.]

	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Hay.	Hay of Vetch and Oats.	Soja-bean Hay.	Barley Straw.
Moisture,	12.42	7.32	10.89	15.00	16.67	16.21	12.80
Nitrogen,	2.56	3.33	5.83	1.47	1.81	2.00	0.86
Phosphoric acid,	2.46	0.37	1.95	0.27	0.50	0.50	0.12
Potassium oxide,	1.60	0.11	1.08	1.50	1.24	1.24	2.60
Valuation per 2,000 pounds,	$13 18	$12 15	$23 55	$7 07	$8 20	$8 86	$5 99
Manurial value obtainable,	10 54	9 72	18 84	5 66	6 56	7 09	4 79

2. EFFECT OF FOOD UPON THE COST AND QUALITY OF MILK.

By J. B. Lindsey.

January–May, 1894.

Objects of the Experiment.

I. To determine how much digestible protein can be economically fed to milch cows.

II. To determine the effect of different quantities of protein upon the quantity and quality of the milk.

Brief Explanation of the Objects Sought.

By digestible protein is meant the nitrogenous part of the food consumed and digested. The non-nitrogenous part, *i.e.*, that which is not protein, is the cellulose, starch, sugars, gums and fatty substances.

Very much is being said at the present time by our experiment stations and intelligent dairy farmers about the value of different rations for the dairy cow. What is the most suitable nutritive ratio * of these fodder rations, or how much protein shall be fed in the ration, is a question of economical importance, for the protein is the most costly of all the fodder constituents.

Again, the writer deems it advisable, partly as an object lesson and partly for more light on the subject, — recognizing at the same time the work already accomplished, — to note the effects of different amounts of protein upon the composition or quality of the milk.

General Teachings of the Experiment.

1. The amount of protein fed in the various fodder rations varied from 1.3 to 3.76 pounds daily to cows averaging 871 pounds live weight. The ration containing the most protein produced milk at a less cost per quart in each

* By nutritive ratio is meant the proportion which the nitrogenous bears to the non-nitrogenous part of the food.

of the three series of experiments, besides furnishing a better quality of manure.

2. During the autumn, winter and spring months from 2.5 to 3 pounds of protein can be fed daily to dairy cows in good condition (on a basis of 1,000 pounds live weight) with economy and consequent profit. During the summer months it might not be advisable to feed over 2.5 pounds of digestible protein in the fodder ration in case of stall-fed cows, and one should be especially careful at that season about feeding grains containing an excess of fat (see caution elsewhere).

3. When as low as 1.3 pounds of protein were fed daily, the total digestible organic matter at the same time being sufficient for the animal's daily needs, the quality of the milk, especially its fat content, was below that produced by a ration containing 2.5 to 3 pounds of digestible protein.

4. When 3 pounds of protein were fed in the daily ration there was an indication that its influence upon the quality of the milk ceased to be felt.*

5. All of the cows were not affected alike by the same fodder ration.

6. The total solid matter in the milk was much less affected than the fat.

7. This experiment points out the economy of feeding properly balanced rations in order to secure maximum and long-continued milk yields, as well as the best quality of manure.

General Introduction.

The German investigator, E. von Wolff,† who has closely studied the results of all German investigators concerning the most suitable fodder rations for milch cows, has given the following standard ration on a basis of 1,000 pounds live weight: —

Digestible protein,	2.50 lbs.
Digestible fat,	0.60 "
Digestible carbohydrates,	13.00 "
Nutritive ratio,	1:5.4

* It is hoped that it will be possible to still further study this question of the effect of food and especially protein upon the quality and quantity of the milk produced.

† Die Ernährung der Landwirthschaftliche Nützthiere, 1876, p. 548.

He claims that about 2.5 pounds of digestible protein should be contained in the ration fed in order to keep the animal in good condition and to keep up the quantity of milk for the longest possible time.

Märcker and Morgen,* as a result of their experiments with five different herds of cows, claim that more protein than the current usage and feeding standards call for can be economically fed, thus: —

	I.	II.
Digestible protein (pounds),	4.06	3.42
Digestible fat (pounds),	0.60	0.50
Digestible carbohydrates (pounds),	13.80	13.84
Nutritive ratio,	1:3.8	1:4.4

While this might be economically true in sections of Germany, it does not necessarily hold that it is economically true in Massachusetts.

Woll † has made quite a thorough inquiry into the rations fed by successful dairymen in different sections of the United States, and calls the average of his results the American standard ration, which he believes to be correct for the larger part of the United States. It is as follows: —

Digestible protein,	2.15 lbs.
Digestible fat,	0.74 "
Digestible carbohydrates,	13.27 "
Nutritive ratio,	1:6.9

He furnishes no results of experiments to prove this to be the case, simply basing his conclusion upon the opinion of dairy farmers. Whether the judgment of dairy farmers is correct or not we will not at this point express an opinion, but it seems to the writer a rather peculiar position for a scientific inquirer to take.

During the winters of 1892–93 and 1893–94 Messrs. Woods and Phelps ‡ made investigations concerning the

* Résumé in Experiment Station Record, March, 1892.

† Bulletin No. 38, Wisconsin Experiment Station.

‡ Bulletin No. 13, Storr's Experiment Station.

fodder rations fed by many prominent dairymen in Connecticut, and found them containing about 2.5 pounds of digestible protein and 17.5 pounds of total digestible nutrients. Where rations poorer in protein were fed than the above, the milk produced was noted, then a change in the ration was suggested, and later the production of the herd was again accurately observed.

They recommended, as a "tentative ration," 2.5 pounds of digestible protein and 16 pounds of total digestible organic matter, — practically the German standard.

The many experiments already carried out at the Massachusetts station have shown the economy of feeding at least 2.5 pounds of digestible protein in the daily ration.

There appears, however, to be a difference in opinion as to the amount of protein that can be *economically fed* to our dairy cows, and the investigation that follows is a step towards the solution of the problem.

In the second place, we have endeavored to note if the varying amounts of protein in rations that contain sufficient total digestible organic nutrients have had any noticeable effect upon the *quality* of the milk produced.

E. Wolff * and G. Kühn † during the years 1868–76 made this subject a special study. The results of their investigation may be stated concisely as follows: —

That milk production is dependent, in the first place, upon the individuality of the cow and upon the development of the milk glands. It is impossible to radically change the composition of the milk by means of food, to transform a "butter cow" into a "cheese cow" at will, etc. On the other hand, there are cows whose milk can be influenced by the foods fed, but only to a limited degree. In the thirty cows that were accurately studied there were only two where such an influence of the fodder was decidedly proved. With some of the other cows very slight changes only were noticed. Of all the milk components, the fat was by far the most influenced by the food supply.

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* E. Wolff, "Die Verssuchsstation Hohenheim," Berlin, 1870.

† Journal für Landw., 1874; Landw. Verssuchsstation, 1869; Résumé in Die Ernährung der Landwirthschaftliche Nützthiere, E. Wolff, 1876.

The one-sided increase in the milk fat in case of individual cows was parallel with the increased supply of digestible protein. Different concentrated feeds appeared also to have increased the percentage of fat.* A previously well-fed cow, fed so as to be poorly nourished,† would decrease in her flow, and the quality of the milk would be, as a rule, gradually impaired, though not radically affected. Upon these experiments of Wolff and Kühn is based our present knowledge of the subject under consideration.

In 1891 W. Fleischmann ‡ presented the results of his studies upon a large herd of cows. He did not study this especial point, namely, the effect of increasing amounts of protein on the quality of the milk; but he makes, in connection with his conclusions, the following interesting observation: "The fact long believed to be true in practice, namely, the increasing the amount of food nutrients to make the milk of cows richer in fat absolutely as well as relatively, would seem to be fully confirmed."

Kochs and Ramm § studied this subject in 1891, using three cows of different breeds, and concluded that in case of their experiment the food had no effect upon the fat content of the milk.

From 2.2 to 4.4 pounds of digestible true protein were fed daily, and approximately 21 to 23 pounds of total digestible organic matter, on the basis of 1,000 pounds live weight. The weakness of this experiment is at least twofold: first, because of the few cows used; and second, because each cow was not fed with the exact ration belonging to her, but the entire food weighed out for the three cows was given to them collectively.

It will be noticed that the smallest amount of protein was 2.25 pounds. The amount of total digestible organic matter fed was, however, above Wolff's standard, so that the nutritive ratio was 1 : 8.00.

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* Palmnut meal and bean meal.

† I wish to state that a milch cow can be poorly nourished in two ways: first, by not getting sufficient food to eat; and second, while she may get enough to eat, the food for milk production might be what is termed an improperly balanced one. Hay, for example, contains a large excess of carbohydrates and not enough protein.

‡ Landw., Jahrb., 20, 1891, Supplement II; Résumé in Experiment Station Record, Vol. III, p. 421.

§ Landw., Jahrb., Bd. xxi, 1892, p. 809.

W. H. Jordan * gives the results of several trials. In the first experiment three cows were used. The animals were fed in the second period of 14 days on hay and corn meal, and in the first and third periods 2 pounds of cotton-seed meal were substituted for 2 pounds of corn meal. Otherwise the food was alike in all three periods. The corn meal ration contained .87 pound of digestible protein and 12.45 pounds total digestible organic nutrients for cows weighing 925 to 950 pounds, — clearly an insufficient amount, as the experimenter states. The cotton-seed ration contained 1.47 pounds of digestible protein and 12.41 pounds of total digestible organic nutrients, also insufficient in quantity, but still somewhat improved. Two of three cows showed a slight increase in the solid matter of the milk on the cotton-seed ration, and one a decrease. The percentage of fat in the milk of the same two cows, on a basis of 13 per cent. total solid matter, was quite uniform for all three periods. The milk of the cow that showed a decrease in per cent. of solid matter on the cotton-seed ration showed at the same time a slight decrease in the fat percentage, on the basis of 13 per cent. total solids.

We have here another example of how different cows are differently affected by similar foods. This experiment was repeated the next year with four cows, but as far as the components of the milk were concerned very little change was noted.

In 1893 the same investigator published the results of experiments with three cows. The total digestible nutrients fed were sufficient, and each period lasted 35 days. The milk was analyzed the last five days of each period.

The writer thinks it would have been better to have had the results of the composition of the milk for five days of each week for every period.

Only the very briefest résumé is here given : —

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* Maine Experiment Station, reports for 1885–86, 1886–87, 1893.

	Protein. Pounds fed.	Total Solids in Milk of Cows. Cow A.	Cow R.	Cow L. S.	Average, Three Cows.
		Per cent.	Per cent.	Per cent.	Per cent.
Wide ration,	1.18	13.39	13.64	13.50	13.51
Narrow ration,	2.09	14.11	13.92	14.27	14.10
Percentage increase of narrow over wide ration,	–	–	–	–	**4.37**

Per Cent. of Fat in Milk on a Basis of Fourteen Per Cent. Solids.

Wide ration,	1.18	4.43	4.45	4.43	4.43
Narrow ration,	2.09	4.68	4.77	4.72	4.73
Percentage increase of narrow over wide ration,	–	**5.64**	**7.19**	**6.54**	**6.50**

This experiment would indicate that the increase of protein in the food had somewhat increased the per cent. of fat in the milk.

The experimenter draws the following conclusion: "In general, the milk was richer while the cows were fed the ration rich in protein, though with one cow it showed the largest per cent. of solids during the third period, while she was eating the corn-meal ration.

"In general, the proportion of fat increased throughout the experiment, without regard to what the cows were fed, and no evidence is furnished in support of the notion that by changing the food it is possible to produce more butter fat without an accompanying increased production of other milk solids."

Armsby * carried out similar experiments with three cows during the years 1885 and 1886. The digestible protein fed during 1885 was from 1.5 to 2 pounds daily and the total digestible organic nutrients 13.5 pounds daily to cows of about 850 pounds live weight. These rations were sufficient in quantity. During 1886 1.1 to 1.8 pounds digestible protein and 12.7 pounds of total organic nutrients were fed. The weight of the animals is not given, but probably they were about the same as in the previous experiment. Armsby

* Wisconsin Experiment Station, reports for 1885 and 1886.

failed to find any change in the composition of the milk that could be traced to food influence.

The New Hampshire Experiment Station * failed to note any decided improvement in the quality of the milk when rations containing sufficient digestible organic nutrients were fed, by varying the digestible protein from 2 to 3 pounds daily.

The Iowa Experiment Station in 1891 published the results of an experiment made " to determine the effect of food upon the quality of milk," without apparently endeavoring to note the effect of any particular group of constituents in the fodder ration. They compared the effect of corn meal (low in protein) with gluten meal (high in protein). They really fed one ration containing but 1.05 pounds of digestible protein and another containing 2.18 pounds. Four cows, averaging 1,000 pounds in live weight, were used in the experiment, — three grade Shorthorn and one grade Holstein. It is impossible, for lack of data, to calculate accurately the amount of digestible nutrients fed, but an attempt has been made below to get an approximate idea. It appears that neither the corn fodder nor the clover hay was tested for moisture or subjected to analysis.

Ration I.		Ration II.	
	Pounds.		Pounds.
Corn and cob meal, . .	$12\frac{1}{2}$	Sugar (gluten) meal, .	10
Corn fodder, . . .	12	Corn fodder, . . .	12
Clover hay, . . .	4	Clover hay, . . .	4

* Bulletins 9 and 10.

	Ration I.	Ration II.	Per Cent. Increase of II. over I.
Digestible protein (pounds), ...	1.05	2.18	–
Total nutrients fed (pounds), ...	14.09	13.51	–
Nutritive ratio, ...	1 : 13.10	1 : 5.71	–
Total yield of milk (pounds), ...	3,302.50	3,399.50	2.94
Total solids (pounds), ...	392.08	428.21	9.21
Fat (pounds), ...	111.25	134.39	20.80
Per cent. of solids in milk, ...	11.93	12.63	5.87
Per cent. of fat in milk, ...	3.37	3.94	16.90
Milk on basis of 12 per cent. total solids (pounds).	3,283.20	3,578.00	8.97
Fat, per cent., basis 12 per cent. solids, .	3.39	3.74	10.32

So far as one is able to judge from the data presented, these rations, other things being equal, were not sufficient for cows of 1,000 pounds live weight that had had calves but a short time previous to the experiment, and yielding 12 to 15 quarts of milk daily. They should apparently have received at least 3 pounds more of total digestible organic matter daily. This insufficient food would of itself have had a tendency to produce a poor quality of milk. In the corn and cob meal ration the protein supply was quite low, and it is surprising that the animals did not shrink more than 9 per cent. in their yield of milk on the basis of 12 per cent. solids below the sugar-meal ration. The milk of Ration I. shows the effect not only of lack of protein but of lack of sufficient food as well. In the sugar-meal ration the replacing of a pound of carbohydrates by a pound of protein is seen in the increase of the solid matter, and especially of the amount of fat. The weight of the animals at the beginning and end of the periods (21 days) is not given, but it is stated that "the variations were not greater than usually appear in the live weight of such animals, and did not surely indicate gain or loss."

It hardly seems possible to the writer that animals fresh

in milk, with an average weight of 1,000 pounds, could be fed on such a food combination as Ration I. and not show the effect of it in a very short time. The data given show that the quantity of the milk was increased and the quality improved, especially its fat content, by increasing the supply of protein in the daily ration. The poor quality of the milk in Ration I. was due in all probability partly to the lack of food and partly to the small amount of protein present. The experiment teaches nothing new, as the investigators seem to think. It has long been recognized that when insufficient rations are fed, and they are at the same time especially lacking in protein, the milk of many cows will show a decrease in quality. The fat has a tendency to be more affected than the other ingredients.

The experiment made at the Massachusetts State Experiment Station about to be described in the following pages is intended first as an object lesson to our dairymen, and secondly it was made with a view of obtaining additional information of an economical as well as of a scientific nature upon this still somewhat disputed question.

Plan of the Experiment.

The experiment was divided into three periods, known as Series I., II. and III. The preliminary feeding generally lasted seven days, and the period itself fourteen. In Series I. it required longer than seven days to get the cows accustomed to the ensilage. In Series III. *a* and *b*, the periods themselves lasted but nine days.

The distinct rations fed will be stated further on. In Series I. *a*, 2.58 pounds of protein (N.R. 1 : 4.8) were fed, and in Series I. *b*, 1.31 pounds of protein (N.R. 1 : 10). The ration *b* represents the way a great many New England farmers feed, while ration *a* is not far from the German standard. In Series II. *a*, 2.55 pounds of protein were fed, essentially the same as in Series I. *a;* and in Series II. *b*, 2.24 pounds of protein (N.R. 1 : 5.8) were fed, rather less in amount, and furnishing, consequently, a somewhat wider nutritive ratio. In this period also we get a direct comparison of the relative effect of Buffalo gluten feed and corn

meal. In Series III. *a*, 2.91 pounds of protein (N.R. 1 : 4.4) were fed, and in Series III. *b*, 3.76 pounds of protein were fed, being relatively large amounts of protein with correspondingly narrow rations.

Strictly speaking, these series, so far as the yield of milk is concerned, can be compared only with themselves, but not with each other, for Series I. *a* and *b* was in operation during the latter part of January and the first half of February, Series II. *a* and *b* was completed about the end of March, and Series III. *a* and *b* about May 1. During this time the cows would naturally shrink some in their milk yield. In order to overcome so far as possible the natural milk shrinkage in comparing the effect of the rations in the three series on the total yield from the herd, the following plan was adopted: take, for example, Series I. *a* and *b*. Cows 1, 2 and 3 were fed the narrow ration, Series I. *a*, during the two weeks that cows 4, 5 and 6 received the wide ration, Series I. *b*; and then the operation was reversed, cows 1, 2 and 3 receiving the wide ration, Series I. *b*, while cows 4, 5 and 6 received the narrow ration, Series I. *a*. This plan was continued through the entire series.

History of Cows.

NAME OF COW.	BREED.	Age (Years).	LAST CALF DROPPED.	Daily Yield of Milk at Beginning of Trial (Quarts).
Nettie, . .	Grade Holstein, .	8	July, 1893,	11
Mary, . .	Grade Durham, .	8	Dec. 17, 1894,	12
Gem, . .	Grade Shorthorn, .	6	Dec. 6, 1891,	9
Sarah, . .	Grade Jersey,. .	6	Dec., 1893,	8½
Nora, . .	Grade Ayrshire, .	6	Mar. 25, 1893,	7
Nellie, . .	Native, . . .	9	Aug. 15, 1893,	10½
Hattie, . .	Grade Jersey, .	6	Mar. 23, 1894,	13

The cows were six in number; during the last period Hattie was substituted for Sarah.

What the Cows were Fed.

In Series I. and II. the coarse fodder consisted of 3 to 4 pounds of dry corn stover and corn ensilage *ad libitum.* The corn ensilage was made from Pride of the North corn, and was cut and put in the silo when the kernels were glazing. It was of good quality. In Series III. the coarse fodder consisted of corn stover and a good quality of rowen.

The grains consisted of wheat bran, corn meal, Buffalo gluten feed, cotton-seed meal and Chicago gluten meal, all of good quality. One ounce of salt was fed daily. Its beneficial effect upon the appetite and circulation is generally acknowledged.

How the Cows were Fed and Kept.

The food was given in two portions, one-half about six o'clock in the morning and the other about four o'clock in the afternoon. The grains were fed dry. The cows were watered twice daily, after eating in the morning and before eating in the afternoon. The animals were well carded and allowed several hours' exercise in the yard whenever weather permitted. The animals were weighed weekly, in the morning before being watered.

Sampling the Milk.

A composite sample of the milk was made for three days of each week (six milkings), and this was taken to represent the average composition of the milk for the week.

*Average Composition of the Daily Fodder Rations (1894).**

Series I.†

a.		*b.*	
Wheat bran,	3.00 lbs.	Wheat bran,	4.50 lbs.
Buffalo gluten feed,	3.00 "	Corn meal,	4.50 "
Cotton-seed meal,	3 00 "	Corn stover,	4 00 "
Corn stover,	4.00 "	Corn ensilage,	43.50 "
Corn ensilage,	42.78 "	Nutritive ratio,	1 : 10
Nutritive ratio,	1 : 4.80	Total cost,	14.99 cts.
Total cost,	15.95 cts.	Manurial value obtainable,	5.84 "
Manurial value obtainable,	8.46 "	Net cost,	9.15 "
Net cost,	7.46 "		

* See digestible nutrients fed to each cow, further on.

† Periods 14 days long.

Average Composition of the Daily Fodder Rations — Concluded.

SERIES II.*

a.		b.	
Wheat bran, ...	3.00 lbs.	Wheat bran, ...	3.00 lbs.
Buffalo gluten feed, . .	3.00 "	Cotton-seed meal, . . .	3.00 "
Cotton-seed meal, . . .	3.00 "	Corn meal, ...	3.00 "
Corn stover, ...	4.00 "	Corn stover, ...	4.00 "
Corn ensilage, . . .	42.97 "	Corn ensilage, . . .	46.41 "
Nutritive ratio, ...	1 : 4.8	Nutritive ratio, ...	1 : 5.8
Total cost, ...	15.97 cts.	Total cost, ...	16.40 cts.
Manurial value obtainable, .	8.47 "	Manurial value obtainable, .	8.00 "
Net cost, ...	7.50 "	Net cost, ...	8.40 "

SERIES III.†

a.		b.	
Wheat bran, ...	3.00 lbs.	Buffalo gluten feed. . .	3.00 lbs.
Cotton-seed meal, . . .	3.00 "	Chicago gluten meal, . .	3.00 "
Corn meal, ...	3.00 "	Cotton-seed meal, . . .	3.00 "
Rowen, ...	9.00 "	Rowen, ...	14.00 "
Corn stover, ...	6.56 "	Corn stover, ...	4.00 "
Nutritive ratio, ...	1 : 4.14	Nutritive ratio, ...	1 : 3.06
Total cost, ...	19.38 cts.	Total cost, ...	20.13 cts.
Manurial value obtainable, .	10.12 "	Manurial value obtainable, .	11.13 "
Net cost, ...	9.26 "	Net cost, ...	9.00 "

* Periods 14 days long. † Periods 9 days long.

Dates of the Series.

	Series I. *a.*	Series I. *b.*
Jan. 16 to Jan. 29, ...	Cows 1, 2 and 3.	Cows 4, 5 and 6.
Feb. 6 to Feb. 19, ...	Cows 4, 5 and 6.	Cows 1, 2 and 3.
	Series II. *a.*	**Series II. *b.***
Feb. 27 to March 12, ...	Cows 1, 2 and 3.	Cows 4, 5 and 6.
March 19 to April 1, ...	Cows 4, 5 and 6.	Cows 1, 2 and 3.
	Series III. *a.*	**Series III. *b.***
April 8 to April 16, ...	Cows 1, 2 and 3.	Cows 4, 5 and 6.
April 22 to April 30, ...	Cows 4, 5 and 6.	Cows 1, 2 and 3.

Table I.

(*a*) *Result of the Inquiry as to the Amount of Protein that can be Economically fed to Milch Cows daily.*

Quantity and Cost of Milk produced per Day.

Feeding Periods.	Nettie.		Mary.		Gem.		Sarah.		Nora.		Nellie.	
	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.	Daily Yield.	Cost per Quart.
	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.	Qts.	Cts.
Series I. *a*,	11.54	1.42	11.16	1.39	9.48	1.67	8.75	1.71	7.81	2.08	10.81	1.51
Series I. *b*,	9.65	1.55	9.75	1.65	8.40	1.78	8.32	1.66	7.26	2.08	10.65	1.41
Series II. *a*,	10.61	1.53	10.21	1.70	9.32	1.69	7.21	2.01	7.04	2.20	9.32	1.66
Series II. *b*,	9.45	1.73	8.26	2.12	8.54	1.02	7.94	1.95	7.29	2.30	10.32	1.60
Series III. *a*,	8.37	2.18	6.87	2.65	7.47	2.41	*13.75	1.50	7.24	2.85	8.92	2.31
Series III. *b*,	10.36	2.07	8.94	2.52	9.22	2.32	13.28	1.40	7.34	2.55	9.17	2.05

* Hattie, new cow.

Table II.

Summary for the Six Cows.

Feeding Periods.	Pounds Protein fed Daily.	Average Weight.	Total Yield of Milk.	Total Cost per Quart.	Net Cost per Quart.	Total Amount of Butter Fat.	Total Cost per Pound.
		Pounds.	Quarts.	Cents.	Cents.	Pounds.	Cents.
Series I. *a*,* .	2.60	878	837.56	1.60	0.77	82.17	16.30
Series I. *b*,* .	1.30	867	756.51	1.66	1.02	67.37	18.67
Series II. *a*,* .	2.55	871	758.60	1.77	0.84	78.20	17.12
Series II. *b*,* .	2.24	873	725.04	1.90	0.97	70.09	19.66
Series III. *a*,† .	2.91	874	473.44	2.21	1.06	45.25	23.12
Series III. *b*,† .	3.76	862	524.94	2.11	0.93	50.95	21.69

* Period 14 days. † Period 9 days.

The above summary furnishes some very instructive lessons.

Series I. a and b.

Series I. *b* shows how a great many farmers feed. The ration contained some corn stover, with corn ensilage *ad libitum*, and 4.5 pounds each of wheat bran and corn meal.

This ration contains but 1.3 pounds of digestible protein. Series I. *a* shows a properly balanced ration, consisting of the same coarse fodders as *b* and three pounds each of wheat bran, Buffalo gluten feed and cotton-seed meal. The approximate total cost of *b* was 15 cents and the net cost 9.15 cents, while the total cost of ration *a* was 16 cents and the net cost 7.5 cents. While the total cost of ration *a* was a trifle more, the net cost was fully 1.5 cents less, due to the fact that this ration furnished a much better manure.

Ration *a* produced 837.5 quarts of milk, at a total cost of 1.6 cents per quart; and ration *b* produced 756.5 quarts of milk, at a total cost of 1.66 cents per quart. Note also that the net cost of a quart of milk in ration *a* was .72 cent and in ration *b* 1.02 cents. Thus not only were 81 quarts more of milk produced during the ration *a* period, but both the total and net cost of the milk were less.

Again, ration *a* produced 82.17 pounds of butter fat, and at a cost of 16.3 cents per pound; while ration *b* produced but 67.37 pounds, at a cost of 18.67 cents per pound. Whether or not the quality of the milk was affected by the different foods will be discussed further on.

The six cows fed on ration *b* showed an average decrease of eleven pounds in live weight. It is certain, however, that more flesh and fat were lost than the scales specified, for during Series I. *b* the animals looked thin and had every appearance of being improperly nourished. In all probability flesh and fat were replaced by water. It is very clear, then, that a ration containing 2.60 pounds of protein was more economical to feed than one containing approximately one-half that amount. This experiment deserves the serious attention of our farmers.

Series II. a and b.

This series can hardly be compared with Series I., as it was later and the animals had naturally shrunk some in their milk production. In ration *a* 2.55 pounds of protein were fed and in ration *b* 2.24 pounds, the only difference in the grain ration being that in ration *b* 3 pounds of corn meal took the place of 3 pounds of Buffalo gluten feed. The live weight of the animals remained constant during this series.

In ration *a* 35 quarts more of milk were produced, at .13 cent less per quart than in ration *b*. The net cost of the milk was correspondingly less. In ration *a* also 8 pounds more of butter fat were produced at 1.5 cents less per pound. These figures show the butter and milk producing power of the Buffalo gluten feed over the corn meal, or, more correctly speaking, the influence of even .25 pound more of digestible protein and also possibly the effect of the increased fat, in the daily fodder ration.

Series III. a and b.

The periods in this series lasted only nine days. In ration *a* 2.91 pounds of digestible protein were fed and in ration *b* 3.76 pounds. Here again we see the influence of the extra amount of protein in the fact that 51 quarts more of milk were produced during the nine-day period (equivalent to 78 quarts during 14 days), at .1 cent less per quart. The net cost of the milk in ration *a* was correspondingly less. In ration *a* 5.7 pounds more of butter fat were produced than in ration *b*, at 1.43 cents less per pound.

So far, then, as this one set of experiments is concerned, the largest amount of protein fed daily, viz., 3.76 pounds, was the most economical. It must be admitted that in feeding so much protein the animal is asked to do her best, and it is a question for how long a time she would be able to continue. The writer believes, however, that during the late fall and winter months cows that are in good condition can be fed from 2.5 to 3 pounds of digestible protein daily with profit. It probably would not be advisable to feed over 2.5 pounds daily to animals that are soiled during the spring, summer and early autumn.

Farmers are especially cautioned not to feed too large an amount of grain during the summer that contains a high percentage of fat. A large amount of fat in the daily ration at this season tends to overheat the animal and produce inflammation of the milk glands. Among such grains may be mentioned cotton-seed meal, Buffalo gluten feed, cream gluten meal, King gluten meal, etc. Not above 4 to 5

quarts of the Buffalo gluten feed or 2 quarts of any of the others should enter into any one daily grain ration during the summer months.

While 2.5 pounds or more of protein have been shown to be economical in the present experiment, the writer believes, with Wolff, that it is also *necessary to keep up the flow of milk for the longest possible time.* The demands upon the cow that produces 10 to 12 quarts of milk daily are severe, and she must be well supplied with sufficient digestible protein to meet these demands.

TABLE III.

(b) Effect of Food (Protein) upon the Quality of the Milk.

Quality of Milk Produced.

Feeding Periods.	Nettie.				Mary.				Gem.				Sarah.				Nora.				Nellie.			
	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*, . .	12.97	4.05	8.92	1:2.20	14.14	5.00	9.14	1:1.83	13.23	4.60	8.63	1:1.88	13.83	4.40	9.43	1:2.14	13.84	4.20	9.64	1:2.30	14.13	4.50	9.63	1:2.14
Series I. *a*, . .	13.23	4.30	8.93	1:2.08	14.11	5.20	8.91	1:1.71	13.38	4.78	8.60	1:1.80	13.72	4.83	8.89	1:1.84	13.72	4.83	8.89	1:1.84	14.12	4.05	10.07	1:2.49
Average, .	13.10	4.18	8.92	1:2.13	14.13	5.10	9.03	1:1.77	13.31	4.69	8.62	1:1.84	13.78	4.62	9.16	1:1.98	13.78	4.52	9.26	1:2.05	14.13	4.28	9.85	1:2.30
Series I. *b*, . .	12.67	2.95	9.72	1:3.29	13.71	3.95	9.76	1:2.47	13.61	3.85	9.76	1:2.54	13.11	4.20	8.91	1:2.12	13.26	4.10	9.16	1:2.23	13.61	4.25	9.36	1:2.20
Series I. *b*, . .	13.33	4.00	9.33	1:2.33	14.18	4.85	9.33	1:1.92	13.12	4.20	8.92	1:2.12	13.41	4.48	8.93	1:1.99	13.59	4.55	9.04	1:1.99	14.11	4.50	9.61	1:2.14
Average, .	13.00	3.48	9.52	1:2.74	13.95	4.40	9.55	1:2.17	13.37	4.03	9.34	1:2.32	13.26	4.34	8.92	1:2.06	13.43	4.33	9.10	1:2.10	13.86	4.38	9.48	1:2.16
Series II. *a*, . .	13.73	4.60	9.13	1:1.98	14.29	5.20	9.09	1:1.75	13.65	4.80	8.85	1:1.84	13.47	5.20	8.27	1:1.59	13.72	4.90	8.82	1:1.80	13.75	4.40	9.35	1:2.13
Series II. *a*, . .	13.42	4.42	9.00	1:2.04	14.12	4.95	9.17	1:1.85	13.46	4.80	8.66	1:1.80	13.43	4.80	8.63	1:1.80	13.76	4.95	8.81	1:1.78	14.71	4.70	10.01	1:2.13
Average, .	13.58	4.51	9.07	1:2.01	14.21	5.08	9.13	1:1.80	13.56	4.80	8.76	1:1.83	13.45	5.00	8.45	1:1.69	13.74	4.93	8.81	1:1.79	14.23	4.55	9.68	1:2.13
Series II. *b*, . .	12.91	4.20	8.71	1:2.07	13.93	5.00	8.93	1:1.79	13.50	4.80	8.70	1:1.81	13.29	4.50	8.79	1:1.95	13.63	4.30	9.33	1:2.17	14.16	4.30	9.86	1:2.29
Series II. *b*, . .	13.50	4.30	9.20	1:2.14	14.65	5.30	9.35	1:1.76	13.57	4.60	8.97	1:1.95	12.62	4.20	8.42	1:2.00	13.46	4.40	9.06	1:2.06	14.27	4.20	10.07	1:2.40
Average, .	13.21	4.25	8.96	1:2.11	14.29	5.15	9.14	1:1.77	13.54	4.70	8.84	1:1.88	12.96	4.35	8.61	1:1.98	13.55	4.35	9.20	1:2.11	14.22	4.25	9.97	1:2.36
Series III. *a*, .	13.47	4.40	9.07	1:2.06	14.11	4.80	9.31	1:1.94	13.13	4.30	8.83	1:2.05	*13.26	4.60	8.66	1:1.88	13.76	4.20	9.56	1:2.28	14.69	4.30	10.39	1:2.42
Series III. *b*, .	13.31	4.05	9.26	1:2.29	14.00	5.00	9.00	1:1.80	13.07	4.20	8.87	1:2.11	13.90	4.75	9.15	1:1.93	13.61	4.30	9.31	1:2.17	14.76	4.70	10.06	1:2.14

* Hattie, new cow.

TABLE IV.

Summary of Averages.

	Digestible Protein Fed (Pounds).	Nettie.				Mary.				Gem.			
		Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*,	2.60	13.10	4.18	8.92	1:2.13	14.12	5.10	9.03	1:1.77	13.31	4.69	8.62	1:1.84
Series I. *b*,	1.30	13.00	3.48	9.52	1:2.74	13.95	4.40	9.55	1:2.17	13.37	4.03	9.34	1:2.32
Per cent. increase *a* over *b*,	-	+0.77	+20.11	−6.30	-	+1.20	+1.60	−5.44	-	−0.45	+16.38	−7.71	-
Series II. *a*,	2.55	13.58	4.51	9.07	1:2.01	14.21	5.08	9.13	1:1.80	13.56	4.80	8.76	1:1.83
Series II. *b*,	2.24	13.21	4.25	8.96	1:2.11	14.29	5.15	9.14	1:1.77	13.54	4.70	8.84	1:1.88
Per cent. increase *a* over *b*,	-	+2.80	+6.12	+1.23	-	−0.56	−1.36	−0.11	-	+0.15	+2.08	−0.90	-
Series III. *a*,	2.91	13.47	4.40	9.07	1:2.06	14.11	4.80	9.31	1:1.94	13.13	4.30	8.83	1:2.05
Series III. *b*,	3.76	13.31	4.05	9.26	1:2.29	14.00	5.00	9.00	1:1.80	13.07	4.20	8.87	1:2.11
Per cent. increase *b* over *a*,	-	−1.19	−7.95	+2.09	-	−0.77	+4.17	−3.33	-	−0.45	−2.33	+0.45	-

TABLE IV. — *Concluded.*

Summary of Averages — Concluded.

	Sarah.				Nora.				Nellie.			
	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.	Total Solids.	Fat.	Solids not Fat.	Fat to Solids not Fat.
Series I. *a*,	13.78	4.62	9.16	1:1.98	13.78	4.52	9.26	1:2.05	14.13	4.28	9.85	1:2.30
Series I. *b*,	13.26	4.34	8.92	1:2.06	13.43	4.33	9.10	1:2.10	13.86	4.38	9.48	1:2.16
Per cent. increase *a* over *b*,	+3.92	+6.45	+2.69	-	+2.61	+4.39	+1.76	-	+1.23	−2.29	+3.90	-
Series II. *a*,	13.45	5.00	8.45	1:1.69	13.74	4.93	8.81	1:1.79	14.23	4.55	9.68	1:2.13
Series II. *b*,	12.96	4.35	8.61	1:1.98	13.55	4.35	9.20	1:2.11	14.22	4.25	9.97	1:2.36
Per cent. increase *a* over *b*,	+3.77	+14.94	−1.89	-	+1.42	+11.76	−4.24	-	−0.07	+7.06	−2.91	-
Series III. *a*,	13.26	4.60	8.66	1: 1.88	13.76	4.20	9.56	1:2.28	14.69	4.30	10.39	1:2.42
Series III. *b*,	13.90	4.75	9.15	1:1.93	13.61	4.30	9.31	1:2.17	14.76	4.70	10.06	1:2.14
Per cent. increase *b* over *a*,	+4.83	+3.26	+6.40	-	−1.09	+2.38	−2.61	-	+0.47	+9.30	−3.17	-

One cannot fail to note the variations in the composition of the milk obtained in the different series. The percentage increase or decrease in the per cent. of total solids is relatively small, being in most cases from 5 to 3 per cent. The percentage variations in the per cent. of fat, on the other hand, are much wider, in some cases as high as 16 per cent. or more being noted. With some of the cows, in cases where more protein was fed, the percentage of solids not fat shows a steady decrease, the fat, on the other hand, increasing even more, showing that the solids not fat were somewhat depressed at the expense of the fat. With other cows this variation in solids not fat was very slight.

Series I. a and b.

In Series I. *b*, when but 1.30 pounds of digestible protein were fed in the daily ration, the amount of fat in the milk is noticeably lower than in Series I. *a*, when double the amount of protein was consumed daily. The percentage increase in the per cent. of the fat in Series I. *a* is also high, varying from 4 to 20 in case of the first five cows.

The total solids were also increased in *a*, but to a much less degree.

The solids not fat showed a percentage of decrease in case of the first three cows of some 6 per cent., and with the last three a slight increase appeared. The ratio of fat to solids not fat should by no means pass unnoticed. In case of the first five cows, in *a* it was as 1 : 1.95, while in *b* as 1 : 2.36.

The cows also differed in what may be termed their susceptibility to the influence of the different fodder rations. The percentage of fat increase in the milk in case of cows Sarah and Nora was not so great as in case of the first three cows; while in case of Nellie the extreme food changes seemed to have had a comparatively small influence on the composition of the milk. The animal appeared, however, to feel more than any of the other cows the bad effect of the improperly combined ration *b*. Her whole general appearance told of a non-suitable food supply. This cow illustrates quite clearly the fact that the composition of the milk of different cows can be differently affected by the same food combinations. Although she gave every appearance of receiving

improper nourishment, she still maintained the quality of her milk. It is to be noticed that the milk of the last three cows appeared to be less affected than that of the first three. This might in a measure at least be due to other than food influences, for the two lots of cows received the same rations at different dates. The temperature of the stable showed no wide variations during either *a* or *b*.

Series II. a and b.

Here the differences are not so marked. Nettie, Sarah, Nora and Nellie show, however, a higher percentage of fat in case of ration *a*, when more protein and fat were fed. The total solids of Nettie, Sarah and Nora are also higher, but the percentage increase is not nearly as marked as in case of the fat. The solids not fat on the whole appear to have been little affected. The ratio of fat to solids not fat for the six cows fed on ration *a* is as 1 : 1.88 ; while ration *b* was fed the ratio is as 1 : 2.03.

Series III. a and b.

The ratio of fat to solids not fat in *a* is as 1 : 2.10 and in *b* as 1 : 2.07, showing practically identical results. The variations in the per cents. of both the solids and the fat are in nearly every case quite small.

In order to get a better illustration of the effect of the food or protein upon the fat of the milk, the following table is presented, showing the fat percentage on the basis of 13 per cent. of solid matter in the milk : —

TABLE V.

Showing Fat Percentages on Basis of 13 Per Cent. Total Solids.

	Protein fed (Pounds).	Nettie. (Per Cent. Fat.)	Mary. (Per Cent. Fat.)	Gem. (Per Cent. Fat.)	Sarah. (Per Cent. Fat.)	Nora. (Per Cent. Fat.)	Nellie. (Per Cent. Fat.)
Series I. *a*,	2.60	4.15	4.69	4.58	4.36	4.27	3.93
Series I. *b*,	1.30	3.48	4.10	3.92	4.25	4.11	4.11
Percentage increase *a* over *b*,	-	+13.51	+14.40	+16.84	+2.59	+3.89	—4.38
Series II. *a*,	2.55	4.32	4.65	4.60	4.83	4.66	4.16
Series II. *b*,	2.24	4.18	4.68	4.51	4.36	4.18	3.88
Percentage increase *a* over *b*,	-	+3.35	±	+2.00	+10.78	+11.48	+7.22
Series III. *a*,	2.91	4.25	4.42	4.26	4.51	3.96	3.81
Series III. *b*,	3.76	3.98	4.64	4.18	4.44	4.11	4.14
Percentage increase *b* over *a*,	-	—6.35	+4.97	—1.88	—1.55	+3.78	+8.66

The same remarks that were made in relation to the previous table apply with equal force here. In Series I. the fat percentage is distinctly higher in *a* than in *b*, the per cent. increase in percentage of fat in case of five cows being from 2.5 to nearly 17 per cent. In Series II. *a*, when 2.55 pounds of protein were fed, the per cent. increase in the percentage of fat is from 2 to 11.50 per cent. above that obtained in *b*, when 2.24 pounds of protein were consumed. In Series III. no distinctly noticeable effect of the food is to be seen on the percentage of fat in the milk.

In Series I., II. and III. *a*, when from 2.55 to 2.91 pounds of digestible protein were fed daily, the percentage of fat in the milk of each of the cows appears to be very even. Two cows show rather wide variations at times, but this can be accounted for only from the condition of the cow, and not from the food influence.

It is well known that the fat content of the milk will vary from time to time when the same fodder ration is fed.

TABLE VI.

Showing Average Results from Six Cows.

	Average Weight of Cows (Pounds).	Average Digestible Nutrients consumed Daily on Basis of 1,000 Pounds Live Weight.*		Nutritive Ratio.	Total Amount of Milk produced on Basis 13 Per Cent. Solids (Pounds).	Total Solid Matter in Milk (Pounds).	Total Butter Fat in Milk (Pounds).	Average Per Cent. Total Solids in Milk.	Average Per Cent. Solids not Fat in Milk with 13 Per Cent. Solids.	Average Per Cent. Butter Fat in Milk with 13 Per Cent. Solids.
		Protein (Pounds).	Total Organic Matter (Pounds).							
Series I. *a*,	878	3.00	15.27	1:4.8	1,897.7	246.7	82.20	13.70	8.63	4.33
Series I. *b*,	867	1.50	15.27	1:10.0	1,685.3	219.25	67.66	13.47	9.01	3.99
Percentage increase *a* over *b*,	-	-	-	-	+12.6	+12.52	+21.49	+1.71	−4.10	+8.52
Series II. *a*,	871	2.93	15.65	1:4.8	1,731.3	225.0	78.44	13.80	8.47	4.53
Series II. *b*,	873	2.57	15.87	1:5.8	1,634.5	212.7	70.30	13.63	8.70	4.30
Percentage increase *a* over *b*,	-	-	-	-	+5.92	+5.78	+11.58	+1.25	−2.67	+5.35
Series III. *a*,	874	3.34	16.32	1:4.4	1,075.2†	139.77	45.30	13.73	8.80	4.20
Series III. *b*,	862	4.32	16.03	1:3.06	1,194.8†	155.31	50.76	13.77	8.75	4.25
Percentage increase *b* over *a*,	-	-	-	-	+11.1	+11.12	+12.05	±	±	+1.19

* Calculated from 871 pounds average weight.

† Nine-day period.

The above table presents the average results obtained from the six cows in each of the three series. The average weight of the herd remained quite constant during the four months' trial, showing a slight decrease in Series I. *b*, when a small amount of protein was fed, and another slight decrease in Series III. *b*, when a very large amount of protein was consumed. The total amount of organic matter fed in each series is practically the same, and, so far as the total digestible nutrients are concerned, the animals can be said to have been well nourished.

Series I. a and b.

The table shows that, with the same amount of total organic matter consumed daily, only one-half the digestible protein (1.50 pounds) was fed in ration *b* that was consumed in ration *a*.

The milk production in *b* decreased 12.60 per cent. on the basis of 13 per cent. solid matter, the total solid matter 12.52 per cent. and the total fat 21.49 per cent. The percentage decrease in the composition of the milk in *b* was in case of the total solids but 1.71 per cent., while in case of fat it was 8.52 per cent. with milk containing 13 per cent. solids. In this Series *a* the average results show the solids not fat were decreased only 4.10 per cent. Attention has already been called to the fact that some cows in this series showed a percentage decrease in the percentage of solids not fat of from 5 to 7 per cent.

The figures would seem to indicate that the lack of protein caused a decrease in the total milk yield, and also a decrease, although not so much, in the composition of the milk itself, especially in the fat content.

Series II. a and b.

The same is true of this series as of the former one. The variation in the protein supply is not so great, the difference being in the substitution of 3 pounds of corn meal for 3 pounds of Buffalo gluten feed. Ration *a*, when more protein was fed, produced 5.92 per cent. more milk with 13 per cent. solids and 5.78 per cent. more solid matter. The amount of fat increased 11.58 per cent. with ration *a*.

A percentage increase of 1.23 per cent. in the per cent. of total solids was noted, and a percentage increase of 5.35 per cent. in the per cent. of total fat on the basis of 13 per cent. solids.

It is quite possible that the high percentage of fat in the Buffalo gluten feed might have been instrumental in causing part, at least, of the increase in the fat percentage of the milk.

Series III. a and b.

In this series the amount of protein fed was very high. The maximum increase in the fat percentage in the milk appears to have been reached, for 4.32 pounds of protein did not seem to cause any increase in either the total solids or fat of the milk. Neither is any increase in the fat percentage to be noted in this period above the other periods, when 3 pounds of digestible protein were fed, being an indication at least that, other things being equal, more than 3 pounds of digestible protein daily ceases to exert any influence on the increase of fat in the milk.*

The increase in the protein supply, however, caused apparently 11.10 per cent. increase in the total yield of milk.

Concluding Observations.

This experiment has some weak points, but it is believed they are not of such a serious nature as to interfere with its general teaching.

For example, the temperature of the stable was not a constant one, not being artificially heated. Again, the cows were divided into two lots, and one lot produced rather more milk daily than the other, but the difference was not excessive.

The milk should have been sampled for four or five days at least in every seven, instead of but for three days.

In the last series different coarse fodders were used from those fed in the two previous ones. The last series was of too short duration, and the first two series might have been

* In this series cow Hattie was substituted for Sarah. This cow gave milk of essentially the same fat content as did Sarah; still, it is not strictly fair to compare one series with another, for this reason.

at least a week longer. The daily supply of protein in each of the series should have been rather more regular in quantity, thus, 1.50, 2.00, 2.50, 3.00, 3.50 pounds, etc. Some rations contained more fat than others, which should have been avoided, for one cannot with certainty say that this increase in the fat supply of the food did not have an influence in increasing the fat in the milk.

The writer would of course draw no *particular conclusion* from this one experiment as to the effect of food, or any one group of food constituents, upon the quality of the milk. The results are simply presented just as they were found, and show what the six cows did in this particular case.

The experiment certainly indicates that rations so put together as to contain 2.5 to 3.5 pounds of digestible protein can be fed with greater profit to the farmer than rations containing 2 pounds.

The milk was principally affected in the first series, when the change from 1.5 to 3 pounds of digestible protein was made. If the change had been more gradual, it is possible that but little change in the milk would have been noted. It would have been interesting to note what the effect would have been on the milk composition if at the end of the three series the ration containing but 1.5 pounds of digestible protein had again been fed.

This experiment coincides with many previous investigations, only in our case the cows seemed to have been more generally affected by the different rations than in case of Kühn's or Wolff's various experiments.

DETAILS OF THE EXPERIMENT. — Daily Feeding Records.

Nettie.

Feeding Periods.	Feed consumed (Pounds) per Day. Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *a*,	3.00	3.00	-	3.00	-	-	4.00	46.11	21.06	2.59	1.14	9.87	13.60	1: 4.91	830-810
I. *b*,	4.50	-	-	-	4.50	-	4.00	43.04	19.99	1.32	0.70	11.43	13.45	1: 10.00	820-835
II. *a*,	3.00	3.00	-	3.00	-	-	4.00	46.96	21.61	2.60	1.10	10.12	13.82	1: 4.95	835-840
II. *b*,	3.00	-	-	3.00	3.00	-	4.00	46.04	21.22	2.22	0.89	10.66	13.77	1: 5.81	810-827
III. *a*,	3.00	-	-	3.00	3.00	9.00	7.67	-	22.23	2.86	0.67	10.80	14.89	1: 4.36	827-820
III. *b*,	-	3.00	3.00	3.00	-	14.00	2.44	-	22.51	3.84	0.91	10.10	14.85	1: 3.24	817-827

Mary.

Feeding Periods.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *a*,	3.00	3.00	-	3.00	-	-	4.00	48.00	20.26	2.59	1.13	10.12	13.84	1: 5.0	963-960
I. *b*,	4.50	-	-	-	4.50	-	4.00	52.61	21.98	1.39	0.77	12.54	14.70	1: 10.4	990-995
II. *a*,	3.00	3.00	-	3.00	-	-	4.00	54.38	23.23	2.66	1.17	11.06	14.89	1: 5.25	992-982
II. *b*,	3.00	-	-	3.00	3.00	-	4.00	54.91	23.15	2.30	0.95	11.97	15.22	1: 6.24	977-960
III. *a*,	3.00	-	-	3.00	3.00	9.00	7.44	-	22.04	2.86	0.67	10.80	14.89	1: 4.36	945-925
III. *b*,	-	3.00	3.00	3.00	-	14.00	2.44	-	22.51	3.84	0.91	10.10	14.85	1: 3.24	925-940

DETAILS OF THE EXPERIMENT — *Concluded.*

Gem.

Feeding Periods.	Feed Consumed (Pounds) per Day. Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *a*,*	3.00	3.00	-	3.00	-	-	4.00	42.11	20.22	2.56	1.05	9.23	12.83	1:4.64	1037-1024
I. *b*,	4.50	-	-	-	4.50	-	4.00	43.30	20.04	1.31	0.67	11.22	13.20	1:9.84	1040-1030
II. *a*,	3.00	3.00	-	3.00	-	-	4.00	41.39	20.40	2.56	1.06	9.50	13.12	1:4.75	1020-1027
II. *b*,	3.00	-	-	3.00	3.00	-	4.00	42.09	20.36	2.18	0.85	10.10	13.13	1:5.61	995-1007
III. *a*,	3.00	-	-	3.00	3.00	9.00	6.60	-	21.36	2.81	0.66	9.92	13.39	1:4.12	1002-972
III. *b*,	-	3.00	3.00	3.00	-	14.00	1.67	-	21.87	3.82	0.90	9.53	14.25	1:3.08	975-1005

Sarah.

Feeding Periods.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio.	Weight of Animal at Beginning and End of Periods (Pounds).
Series I. *b*,	4.50	-	-	-	4.50	-	4.00	33.89	17.96	1.22	0.63	10.09	11.94	1:9.56	755-772
I. *a*,	3.00	3.00	-	3.00	-	-	4.00	35.09	18.81	2.53	1.04	8.70	12.27	1:4.46	805-810
II. *b*,	3.00	-	-	3.00	3.00	-	4.00	39.00	19.72	2.21	0.86	10.05	13.12	1:5.52	820-815
II. *a*,	3.00	3.00	-	3.00	-	-	4.00	31.14	18.14	2.44	1.02	8.07	11.53	1:4.35	790-770
III. *b*,†	-	3.00	3.00	3.00	-	9.00	5.67	-	20.77	3.68	0.88	8.72	13.28	1:2.94	905-865
III. *a*,	3.00	-	-	3.00	3.00	14.00	2.11	-	22.05	2.97	0.69	10.17	14.03	1:4.00	863-885

Nora.

Series I. b,	4.50	-	-	-	4.50	-	4.00	44.36	20.14	1.31	0.71	11.39	13.41	1:10.00	813-800
I. a,	3.00	3.00	-	3.00	-	-	4.00	45.41	20.96	2.60	1.12	9.95	13.67	1: 4.09	825-845
II. b,	3.00	-	-	3.00	3.00	-	4.00	49.29	21.96	2.29	0.93	11.28	14.50	1: 5.94	825-825
II. a,	3.00	3.00	-	3.00	-	-	4.00	39.07	19.86	2.51	1.04	9.26	11.86	1: 4.73	812-825
III. b,	-	3.00	3.00	3.00	-	9.00	5.89	-	20.95	3.68	0.88	8.72	13.28	1: 2.94	805-785
III. a,	3.00	-	-	3.00	3.00	14.00	1.89	-	21.87	2.97	0.69	10.17	14.03	1: 4.00	840-850

Nellie.

Series I. b,	4.50	-	-	-	4.50	-	4.00	43.80	20.02	1.30	0.68	11.24	13.22	1:9.96	805-750
I. a,	3.00	3.00	-	3.00	-	-	4.00	45.66	21.01	2.60	1.09	9.88	13.57	1:4.84	815-812
II. b,	3.00	-	-	3.00	3.00	-	4.00	47.14	21.49	2.26	0.91	10.89	13.16	1:5.82	815-805
II. a,	3.00	3.00	-	3.00	-	-	4.00	44.86	21.13	2.55	1.07	9.82	13.44	1:4.90	775-785
III. b,	-	3.00	3.00	3.00	-	9.00	6.08	-	21.11	3.68	0.88	8.72	13.28	1:2.94	757-732
III. a,	3.00	-	-	3.00	3.00	14.00	2.03	-	21.98	2.97	0.69	10.17	14.03	1:4.00	766-792

* Period only eight days.

† Hattie, new cow.

TOTAL AMOUNTS OF FEEDS FED AND TOTAL COST OF FEED PER QUART OF MILK.

Nettie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *a*, ...	161.63	11.54	42.00	42.00	–	42.00	–	–	56.00	645.54	$2 29	1.42
I. *b*, ...	135.12	9.65	63.00	–	–	–	63.00	–	56.00	602.56	2 09	1.55
II. *a*, ...	148.60	10.61	42.00	42.00	–	42.00	–	–	56.00	637.44	2 28	1.53
II. *b*, ...	132.33	9.45	42.00	–	–	42.00	42.00	–	56.00	644.56	2 29	1.73
III. *a*, ...	75.35	8.37	27.00	–	–	27.00	27.00	81.00	69.03	–	1 64	2.18
III. *b*, ...	93.26	10.36	–	27.00	27.00	27.00	–	126.00	21.96	–	2 03	2.07

Mary.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *a*, ...	160.00	11.16	42.00	42.00	–	42.00	–	–	56.00	592.06	$2 22	1.39
I. *b*, ...	136.51	9.75	63.00	–	–	–	63.00	–	56.00	736.54	2 26	1.65
II. *a*, ...	143.02	10.21	42.00	42.00	–	42.00	–	–	56.00	761.32	2 44	1.70
II. *b*, ...	115.51	8.26	42.00	–	–	42.00	42.00	–	56.00	768.74	2 44	2.12
III. *a*, ...	61.81	6.87	27.00	–	–	27.00	27.00	81.00	66.96	–	1 64	2.65
III. *b*, ...	80.47	8.94	–	27.00	27.00	27.00	–	126.00	21.96	–	2 03	2.52

Gem.												
Series I. *a*,*	75.81	9.48	24.00	24.00	–	24.00	–	–	32.00	336.88	$1 27	1.67
I. *b*,	117.67	8.40	63.00	–	–	–	63.00	–	56.00	606.20	2 09	1.78
II. *a*,	130.47	9.32	42.00	42.00	–	42.00	–	–	56.00	579.46	2 21	1.69
II. *b*,	119.53	8.54	42.00	–	–	42.00	42.00	–	56.00	589.26	2 22	1.02
III. *a*,	67.21	7.47	27.00	–	–	27.00	27.00	81.00	59.49	–	1 62	2.41
III. *b*,	83.02	9.22	–	27.00	27.00	27.00	–	126.00	15.03	–	1 93	2.32
Sarah.												
Series I. *b*,	116.51	8.32	63.00	–	–	–	63.00	–	56.00	474.46	$1 93	1.66
I. *a*,	122.56	8.75	42.00	42.00	–	42.00	–	–	56.00	491.26	2 10	1.71
II. *b*,	111.16	7.94	42.00	–	–	42.00	42.00	–	56.00	546.00	2 17	1.95
II. *a*,	100.93	7.21	42.00	42.00	–	42.00	–	–	56.00	435.96	2 03	2.01
III. *b*,†	119.58	13.28	–	27.00	27.00	27.00	–	81.00	51.03	–	1 68	1.40
III. *a*,	123.72	13.75	27.00	–	–	27.00	27.00	126.00	18.99	–	1 86	1.50
Nora.												
Series I. *b*,	101.63	7.26	63.00	–	–	–	63.00	–	56.00	621.04	$2 11	2.08
I. *a*,	109.30	7.81	42.00	42.00	–	42.00	–	–	56.00	635.74	2 28	2.08
II. *b*,	102.09	7.29	42.00	–	–	42.00	42.00	–	56.00	690.06	2 35	2.30
II. *a*,	98.60	7.04	42.00	42.00	–	42.00	–	–	56.00	546.98	2 16	2.20
III. *b*,	66.05	7.34	–	27.00	27.00	27.00	–	81.00	53.01	–	1 69	2.55
III. *a*,	65.12	7.24	27.00	–	–	27.00	27.00	126.00	17.01	–	1 85	2.85

* Period only eight days. † Hattie, new cow.

TOTAL AMOUNTS OF FEEDS FED AND TOTAL COST OF FEED PER QUART OF MILK — *Concluded.*

Nellie.

FEEDING PERIODS.	Quantity of Milk produced (Quarts).	Average Daily Yield (Quarts).	Wheat Bran consumed (Pounds).	Buffalo Gluten Feed consumed (Pounds).	Chicago Gluten Meal consumed (Pounds).	Cotton-seed Meal consumed (Pounds).	Corn Meal consumed (Pounds).	Rowen consumed (Pounds).	Corn Stover consumed (Pounds).	Corn Ensilage consumed (Pounds).	Total Cost of Feed consumed.	Cost of Feed per Quart of Milk produced (Cents).
Series I. *b*,	149.07	10.65	63.00	–	–	–	63.00	–	56.00	613.20	$2 10	1.41
I. *a*,	151.40	10.81	42.00	42.00	–	42.00	–	–	56.00	639.24	2 28	1.51
II. *b*,	144.42	10.32	42.00	–	–	42.00	42.00	–	56.00	659.96	2 31	1.60
II. *a*,	136.98	9.32	42.00	42.00	–	42.00	–	–	56.00	628.04	2 27	1.66
III. *b*,	82.56	9.17	–	27.00	27.00	27.00	–	81.00	54.72	–	1 69	2.05
III. *a*,	80.23	8.92	27.00	–	–	27.00	27.00	126.00	18.27	–	1 85	2.31

*Average Analyses of the Various Articles of Fodder.**

FODDER ANALYSES.	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Dry Matter.								
Crude ash,	7.01	0.94	0.14	7.31	1.29	7.62	7.14	4.53
" cellulose,	11.17	8.18	1.73	6.14	1.98	26.09	33.38	33.30
" fat,	5.89	14.27	4.60	10.63	4.90	3.28	1.59	4.28
" protein,	17.92	23.45	37.09	48.64	11.07	14.42	9.91	6.31
Nitrogen-free extract	58.01	53.16	56.44	27.28	80.76	48.59	47.98	51.58
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Several lots of some of the different grains were purchased, but they varied so little in composition that only an average analysis is here presented.

Digestion Coefficients.

	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Crude cellulose,	25	43	–	–	77	64	67	63
" fat,	72	81	88	97	85	46	52	80
" protein,	78	85	87	88	72	62	52	53
Nitrogen-free extract,	68	81	91	64	94	66	64	68

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Wheat Bran	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Moisture,	13.00	9.00	9.00	8.00	16.00	12.00	17.00	79.00
Nitrogen,	2.49	3.42	5.38	7.16	1.49	2.03	1.32	0.21
Phosphoric acid,	2.46	0.35	0.42	2.37	0.70	0.62	0.05	0.03
Potassium oxide,	1.58	0.06	0.07	1.70	0.40	1.83	1.82	0.41
Valuation per 2,000 pounds,	$11 51	$10 67	$16 65	$25 55	$5 57	$8 54	$5 83	$1 05
Manurial value obtainable,	9 21	8 54	13 32	20 44	4 46	6 83	4 66	0 84

Dry-matter Determinations of Foods Fed.

	Wheat Bran.	Buffalo Gluten Feed.	Chicago Gluten Meal.	Cotton-seed Meal.	Corn Meal.	Rowen.	Corn Stover.	Corn Ensilage.
Series I. { a. Cows 1, 2, 3, } { b. Cows 4, 5, 6, }	85.68	91.80	-	93.20	82.51	-	82.85	20.87
Series I. { b. Cows 1, 2, 3, } { a. Cows 4, 5, 6, }	87.35	91.80	-	93.20	83.59	-	82.85	20.87
Series II. { a. Cows 1, 2, 3, } { b. Cows 4, 5, 6, }	86.80	89.59	-	92.38	84.14	-	82.85	21.80
Series II. { b. Cows 1, 2, 3, } { a. Cows 4, 5, 6, }	86.80	89.50	-	91.46	83.94	-	82.85	21.80
Series III. { a. Cows 1, 2, 3, } { b. Cows 4, 5, 6, }	87.12	89.50	90.28	91.90	86.30	88.00	82.85	-
Series III. { b. Cows 1, 2, 3, } { a. Cows 4, 5, 6, }	87.60	89.00	91.00	92.80	86.30	88.00	82.00	-

Dry Matter in Refuse left in Mangers.

Feeding Periods.	Nettie.	Mary.	Gem.	Sarah.	Nora.	Nellie.
Series I. *a*,	23.00	21.00	50.00	21.00	22.00	28.00
Series I. *b*,	19.00	19.00	38.00	22.00	21.00	23.00
Series II. *a*,	34.00	25.00	30.00	25.00	24.00	30.00
Series II. *b*,	31.00	21.00	39.00	21.00	26.00	32.00
Series III. *a*,	77.00	79.00	78.00	88.00*	80.00	81.00
Series III. *b*,	85.00	85.00	86.00	68.00*	72.00	72.00

* Hattie, new cow.

Average Composition of the Waste (Dry Matter).

	Per Cent.
Crude ash,	5.10
" cellulose,	39.00
" fat,	1.70
" protein,	6.70
Nitrogen-free extract,	47.50
	100.00

The waste in all of the periods was of the same character, viz., the coarser portion of the corn stalks from the corn stover and ensilage. The amount left by each of the cows

in each series was carefully sampled and tested. It proved to be so identical in composition that one average analysis is given, which it is believed will fairly represent the composition of the whole.

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
Chicago gluten meal,	25 00
Cotton-seed meal,	26 00
Corn meal,	19 00
Rowen,	15 00
Corn stover,	5 00
Corn ensilage,	2 50

Temperature of Stable (Fahr.).

Date.	Temperature.	Date.	Temperature.
Series I., Jan. 16,	45	Series II., March 8,	47
17,	42	9,	50
18,	38	10,	55
19,	44	11,	54
20,	42	12,	52
21,	41	19,	62
22,	46	20,	55
23,	42	21,	50
24,	45	22,	53
25,	42	23,	48
26,	37	24,	45
27,	40	25,	49
28,	39	26,	42
29,	35	27,	42
Feb. 6,	35	28,	41
7,	38	29,	45
8,	46	30,	45
9,	45	31,	47
10,	46	April 1,	47
11,	43	Series III., April 8,	45
12,	36	9,	44
13,	34	10,	46
14,	34	11,	45
15,	37	12,	44
16,	34	13,	48
17,	30	14,	52
18,	43	15,	56
19,	42	16,	55
Series II., Feb. 27,	40	22,	59
28,	41	23,	59
March 1,	45	24,	58
2,	47	25,	58
3,	49	26,	60
4,	49	27,	65
5,	51	28,	64
6,	57	29,	61
7,	56	30,	63

3. CREAMERY RECORD OF THE STATION.

1893–94.

The cost of feed consumed is based on the market prices stated below. The valuation of the whole milk is taken at three cents per quart.

Local Market Cost per Ton of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	20 00
Peoria gluten feed,	20 00
King gluten meal,	25 00
Chicago gluten meal,	25 00
Cotton-seed meal,	26 00
New-process linseed meal,	28 00
Corn meal,	19 00
Corn and cob meal,	18 00
Mixed grains,	22 00
Hay,	15 00
Rowen,	15 00
Green fodder corn,	2 50
Corn stover,	5 00
Corn ensilage,	2 50
Soja-bean hay,	15 00
Vetch and oats (dry),	15 00
Barley straw,	10 00
Green rye,	2 50
Vetch and oats (green),	2 50
Hungarian grass (green),	2 50
Buckwheat (green),	2 50
Mixed green crops,	2 50
Potatoes,	2 50

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

FERTILIZER ANALYSES.	Moisture.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	Valuation per 2,000 Pounds.
Wheat bran,	11.00	2.48	2.85	1.63	$11 92
Buffalo gluten feed,	8.80	3.78	0.05	0.10	11 49
Peoria gluten feed,	8.50	3.50	0.05	0.10	10 65
King gluten meal,	7.80	5.69	0.69	0.08	17 84
Chicago gluten meal,	8.50	5.10	0.42	0.05	15 77
Cotton-seed meal,	8.00	6.47	2.75	1.98	24 14
New-process linseed meal,	11.00	5.83	1.95	1.08	20 52
Corn meal,	16.00	1.49	0.70	0.40	5 57
Corn and cob meal,	23.00	1.23	0.70	0.40	4 79
Mixed grains,	12.00	3.50	1.30	1.00	12 80
Hay,	15.00	1.47	0.27	1.50	6 18
Rowen,	12.00	1.72	0.47	1.63	7 26
Green fodder corn,	80.00	0.19	0.15	0.33	1 05
Corn stover,	17.00	1.32	0.05	1.82	5 83
Corn ensilage,	79.00	0.21	0.03	0.41	1 05
Soja-bean hay,	16.00	2.00	0.50	1.24	7 74
Vetch and oats (dry),	17.00	1.81	0.50	1.24	7 17
Barley straw,	13.00	0.86	0.12	2.60	5 30
Green rye,	72.00	0.30	0.12	0.64	1 66
Vetch and oats (green),	75.00	0.44	0.13	0.42	1 87
Hungarian grass (partly dry),	60.00	0.60	0.24	0.80	2 84
Buckwheat (green),	85.00	0.44	0.09	0.54	1 95
Mixed green crops,	80.00	0.43	0.15	0.35	1 79
Potatoes,	80.00	0.33	0.13	0.59	1 71

Fertilizing Constituents of Cream.

[Average analysis.]

	Per Cent.
Moisture at 100° C.,	72.00–74.00
Nitrogen (15 cents per pound),	0.54
Phosphoric acid (5 cents per pound),	0.17
Potassium oxide (5 cents per pound),	0.12

The monthly value placed upon the cream is the price paid for the same by the local creamery. The financial statement is based on the local cost of feed, and does not take into consideration interest on investment or cost of labor involved.

The results here presented are stated under the following separate headings : —

1. Statement of articles of fodder used.
2. Value of cream at creamery basis of valuation.
3. Cost of skim-milk on the basis of three cents per quart for whole milk.
4. Analyses of milk and cream.
5. What the creamery records show.

1. Statement of Articles of Fodder used during 1893 (Pounds).

1893.	Wheat Bran.	Buffalo Gluten Feed:	Cotton-seed Meal.	New-process Linseed Meal.	Hay.	Rowen.	Green Fodder Corn.	Corn Stover.	Corn and Soja-bean Ensilage.	Soja-bean and Corn Ensilage.	Serradella and Hungarian Grass Ensilage.	Soja-bean Hay.	Peas and Oats (Dry).	Vetch and Oats (Dry).	Barley Straw.	Vetch and Oats (Green).	Buckwheat (Green).	Vetch (Green).
January, .	489.00	489.00	442.00	-	1,080.00	-	-	742.50	2,968.50	-	-	-	-	-	-	-	-	-
February, .	504.00	504.00	491.00	-	798.00	-	-	-	7,084.00	-	-	-	-	-	-	-	-	-
March, .	516.00	516.00	507.00	-	721.00	-	-	-	9,103.00	-	-	-	-	-	-	-	-	-
April, .	507.00	507.00	426.00	-	781.00	-	-	-	2,530.00	1,370.00	4,751.00	-	-	-	-	-	-	-
May, . .	555.00	555.00	555.00	-	753.00	-	-	-	-	9,233.00	-	-	-	448.00	-	-	-	-
June, .	540.00	540.00	540.00	-	-	942.00	-	-	-	-	-	-	1,564.00	184.00	-	-	-	-
July, . .	558.00	558.00	409.50	130.50	-	1,820.00	-	-	-	-	-	-	-	-	-	3,880.00	-	-
August, .	558.00	558.00	-	558.00	-	2,726.00	-	-	-	-	-	-	-	-	-	-	633.00	252.00
September,	531.00	531.00	-	519.00	264.00	636.00	948.00		-	-	-	-	-	-	-	-	-	-
October, .	558.00	558.00	-	558.00	1,757.00	-	7,818.00	-	-	-	-	-	-	-	-	-	-	-
November,	540.00	540.00	-	540.00	-	-	-	-	-	-	-	-	129.00	2,877.00	-	-	-	-
December,	551.00	551.00	-	539.00	72.00	-	-	-	-	-	-	2,139.00	-	49.00	971.00	-	-	-

1. STATEMENT OF ARTICLES OF FODDER USED DURING 1894 (POUNDS).

1894.	Wheat Bran.	Buffalo Gluten Feed.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Cotton-seed Meal.	New-process Linseed Meal.	Corn Meal.	Corn and Cob Meal.	Mixed Grains.	Hay.	Rowen.
January,	679.00	292.00	-	-	-	236.00	52.00	368.00	-	-	162.00	-
February,	590.00	255.00	-	-	-	324.00	-	344.00	-	-	-	-
March,	558.00	279.00	-	-	-	558.00	-	279.00	-	-	-	-
April,	279.00	270.00	-	-	261.00	540.00	-	270.00	-	-	-	1,986.00
May,	765.00	-	-	322.00	317.00	126.00	-	126.00	-	-	-	1,452.00
June,	671.00	-	-	338.00	333.00	-	-	-	-	248.00	-	2,447.00
July,	233.00	233.00	-	233.00	-	-	-	-	-	864.00	-	1,305.00
August,	803.00	293.00	-	390.00	-	-	-	-	341.00	-	-	2,325.00
September,	732.00	-	416.00	227.00	-	-	-	-	36.00	-	-	690.00
October,	899.00	-	472.00	55.00	6.00	-	-	-	15.00	-	-	-

1. Statement of Articles of Fodder used during 1894 (Pounds) — *Concluded.*

1894.	Green Fodder Corn.	Corn Stover.	Corn Ensilage.	Soja-bean Hay.	Vetch and Oats (Dry).	Barley Straw.	Green Rye.	Vetch and Oats (Green).	Hungarian Grass (Green).	Buckwheat (Green).	Mixed Green Crops.	Potatoes.
January,	-	572.00	7,840.00	288.00	-	40.00	-	-	-	-	-	-
February,	-	672.00	8,610.00	-	-	-	-	-	-	-	-	-
March,	-	744.00	9,085.00	-	-	-	-	-	-	-	-	-
April,	-	1,170.00	295.00	-	-	-	-	-	-	-	-	-
May,	-	294.00	-	-	-	-	4,801.00	-	-	-	-	-
June,	-	-	-	-	-	-	-	1,525.00	-	-	580.00	-
July,	-	-	-	-	-	-	-	5,350.00	-	1,100.00	1,310.00	-
August,	3,630.00	-	-	-	-	-	-	-	-	-	-	-
September,	6,255.00	-	-	-	-	-	-	-	1,270.00	-	-	520.00
October,	-	1,410.00	-	390.00	288.00	-	-	-	3,186.00	-	-	1,920.00

2. Value of Cream at Creamery Basis of Valuation.

	Total Cost of Feed consumed.	Total Value of Fertilizing Constituents of Food consumed.	Value of Fertilizing Constituents lost in Cream.	Net Cost of Feed for Production of Cream.	Value of Cream produced.
1893.					
January,	$30 41	$22 81	$0 67	$12 83	$41 69
February,	32 44	20 05	80	17 20	49 39
March,	35 07	24 91	91	16 05	56 32
April,	33 59	25 42	70	13 95	41 24
May,	40 29	27 98	70	18 61	38 95
June,	38 27	28 48	62	16 11	32 80
July,	36 81	26 34	61	16 35	31 57
August,	40 31	26 74	60	19 52	31 32
September,	33 61	18 99	55	18 97	32 88
October,	41 57	28 68	61	19 24	36 32
November,	40 10	30 93	55	15 91	32 72
December,	39 56	26 75	51	18 67	30 76
Averages,	$36 84	$25 67	$0 65	$16 95	$38 00
1894.					
January,	$31 43	$17 65	$0 70	$18 01	$36 97
February,	28 08	16 33	60	15 62	31 35
March,	31 21	19 39	66	16 36	33 47
April,	33 90	23 31	61	15 86	28 56
May,	29 72	21 91	64	12 83	27 55
June,	38 47	22 06	59	21 41	24 92
July,	36 44	22 32	50	19 08	22 25
August,	40 49	21 12	62	24 21	30 28
September,	29 42	16 71	47	16 52	25 29
October,	29 16	21 29	46	12 59	25 92
Averages,	$32 83	$20 21	$0 59	$17 25	$28 66

3. Cost of Skim-milk on the Basis of Three Cents per Quart for Whole Milk.

	Quarts of Milk produced.	Spaces of Cream.	Quarts of Cream (One Quart equals 3.4 Spaces).	Quarts of Skim-milk.	Value of Cream per Space (Cents).	Value of Cream per Quart of Milk (Cents).	Total Value of Cream.	Cost of Skim milk per Quart (Whole Milk at Three Cents per Quart).	Total Cost of Skim-milk.
1893.									
January, .	1,625.2	981.0	288.5	1,336.5	4.25	2.57	$41 69	0.53	$7 06
February, .	2,007.4	1,176.0	345.9	1,651.5	4.20	2.46	49 39	0.66	10 83
March, . .	2,332.5	1,341.0	394.4	1,938.1	4.20	2.41	56 32	0.70	13 65
April, . .	2,008.7	1,031.0	303.2	1,705.5	4.00	2.05	41 24	1.11	19 02
May, . .	1,997.6	1,025.0	301.5	1,696.1	3.80	1.98	38 95	1.24	20 97
June, . .	1,668.6	911.0	267.9	1,400.7	3.60	1.96	32 80	1.23	17 25
July, . .	1,632.2	902.0	265.3	1,366.9	3.50	1.93	31 57	1.16	17 39
August, .	1,743.9	870.0	258.9	1,495.0	3.60	1.61	31 32	1.41	20 99
September, .	1,605.6	822.0	241.8	1,363.8	4.00	2.04	32 88	1.12	15 28
October, .	1,811.3	908.0	267.1	1,544.2	4.00	2.01	36 32	1.17	18 02
November, .	1,694.8	818.0	240.6	1,454.2	4.00	1.93	32 72	1.25	18 12
December, .	1,626.3	769.0	226.2	1,400.1	4.00	1.89	30 76	1.29	18 03
Averages, .	1,812.8	962.8	283.4	1,529.4	3.93	2.07	$38 00	1.07	$16 39
1894.									
January, .	1,879.5	973.0	286.2	1,593.3	3.80	1.97	$36 97	1.22	$19 42
February, .	1,569.3	836.0	253.8	1,315.5	3.75	2.00	31 35	1.20	15 73
March, . .	1,637.9	917.0	269.7	1,368.2	3.65	2.04	33 47	1.15	15 67
April, . .	1,639.2	850.0	250.0	1,389.2	3.36	1.74	28 56	1.48	20 62
May, . .	1,903.0	889.0	261.5	1,641.5	3.10	1.45	27 55	1.77	29 54
June, . .	1,905.1	817.0	240.3	1,664.8	3.05	1.31	24 92	1.94	32 23
July, . .	1,683.5	704.0	207.1	1,476.4	3.16	1.32	22 25	1.91	28 26
August, .	1,633.3	865.0	254.4	1,378.9	3.50	1.85	30 28	1.35	18 72
September, .	1,593.7	657.0	193.2	1,400.5	3.85	1.59	25 29	1.68	22 52
October, .	1,480.0	648.0	190.6	1,289.4	4.00	1.75	25 92	1.43	18 48
Averages, .	1,692.5	815.6	240.7	1,451.8	3.52	1.70	$28 66	1.51	$22 12

4. Analyses of Milk and Cream.

The station herd consisted of six cows of various grades, purchased in the vicinity, and are fair representatives of the cows kept by average farmers of this section. Here follows the monthly average of the composition of the milk.

As some of the cows were replaced by others during the year, no particular conclusions can be drawn relative to the difference in the solids and fat percentages.

	Total Solids.	Fat.
January,	13.49	4.33
February,	13.65	4.17
March,	13.71	4.66
April,	13.76	4.47
May,	13.49	3.93
June,	13.36	4.12
July,	13.48	4.44
August,	–	–
September,	13.85	3.87*
October,	–	4.47

* Cows not in good condition; fat percentage noticeably affected.

Composition of Cream.

The station cream, obtained by the Cooley process, when properly treated and the skim-milk carefully drawn, contains about 18.50 per cent. of fat.

5. What the Creamery Record Shows.

1. The nutritive ratio of the feed varied in 1893 from 1 : 3.50 to 1 : 5.00, with an average of 1 : 4.38; in 1894 from 1 : 4.50 to 1 : 5.50, with an average of 1 : 5.00.

2. The average monthly percentage of fat in the milk varied in 1893 from 4.37 to 4.84, with an average of 4.59; in 1894 from 3.87 to 4.47, with an average of 4.27.

3. The average monthly percentage of total solids varied in 1893 from 13.64 to 14.01, with an average of 13.84; in 1894 from 13.36 to 13.85, with an average of 13.60.

4. The relation of fat to solids not fat in 1893 was 1 : 2.02, while in 1894 it was 1 : 2.18.

5. The total cost of feed for one quart of cream amounted in 1893 to 13.00 cents and in 1894 to 13.64 cents.

6. The net cost of feed for one quart of cream amounted in 1893 to 5.98 cents and in 1894 to 7.17 cents.

7. The value received for one space of cream varied in 1893 from 3.50 to 4.25 cents, with an average of 3.93 cents; in 1894 from 3.10 to 4.00 cents, with an average of 3.52 cents, which amounted per quart (average) in 1893 to 13.36 cents, and in 1894 to 11.97 cents.

8. The number of quarts of milk required to produce one space of cream in 1893 was 1.88 and in 1894 2.08; or 6.39 quarts of whole milk to produce one quart of cream in 1893, and 7.07 quarts of whole milk to produce one quart of cream in 1894.

9. The net cost of feed per quart of cream averaged in 1893 5.98 cents and in 1894 7.17 cents. Received per quart of cream in 1893 13.36 cents and in 1894 11.97 cents, thereby securing a profit of 7.38 cents per quart in 1893 and 4.80 cents in 1894.

Our average statements for the current year apply in each case to only ten months, due to the fact that the financial settlement is made with our local creamery two months after the cream is furnished.

IV.

HAY SUBSTITUTES.

By J. B. Lindsey.

Vetch and Oats and Peas and Oats.

The many experiments made at this station have pointed out the costliness of English hay as a coarse fodder for milk production, and the substitution of other coarse fodders in its place. Among those fodders with which good success has been obtained may be mentioned vetch and oats and peas and oats. These fodders have given quite satisfactory results, both when fed green and when made into hay.

The results of two experiments may be cited. In one case rowen and hay of peas and oats were compared, and in another good English hay and hay of vetch and oats. The grain fed was constant in each case during the entire experiment.

I.

[Rowen *vs.* hay of peas and oats. Summer of 1893. Average results from four cows. Length of rowen period, 9 days; peas and oats period, 14 days.]

	Rowen.	Peas and Oats.
Average daily yield of milk, . . .	9.33 qts.	9.30 qts.
Average cost per quart, . . .	2.47 cts.	2.35 cts.

II.

[English hay *vs.* hay of vetch and oats. Autumn of 1894. Average results from six cows. Length of English hay period, 12 days; vetch and oats period, 34 days.]

	English Hay.	Vetch and Oats.
Average daily yield of milk, . . .	10.22 qts.	9.43 qts.
Average cost of milk per quart, . . .	2.25 cts.	2.35 cts.

In case of I. the yield and cost of milk are practically identical, while in II. the hay has slightly the advantage. This is, however, largely offset when it is noted (see summary above) that the vetch and oats period was four times as long as the hay period; cows would naturally shrink somewhat in their yield during this time. The cows gained in flesh during the vetch and oats period.

Yield per Acre of Vetch and Oats.

We have succeeded in raising on an average about three tons of hay per acre. It begins to bloom between the 25th of June and the 10th of July, depending of course on the season. It can be fed as a green fodder for some ten days, and the remainder made into hay, or it can be cut directly.

Several lots of seed can be sown some ten days apart in the spring, and green fodder thus secured for nearly a month.

After cutting the vetch and oats the land can be ploughed and planted to a second fodder crop. We followed vetch and oats this year with Hungarian grass, and in spite of the extremely dry season succeeded in getting one ton per acre of Hungarian hay. Had there been a fair amount of rainfall, this yield would certainly have been doubled. By this method four tons of hay per acre of an equal value with good English hay were secured. The land was manured with ten tons of barn-yard manure in the spring, and received no other fertilizer during the season. In place of the manure six hundred pounds of ground bone with two hundred pounds of muriate of potash would have answered the same purpose.

Seed per Acre.

It has been found that four bushels of oats and fifty pounds of vetch are about the right quantities and proportion for one acre. Both seeds are sown at the same time, and harrowed in. In our case an Acme harrow was used.

Composition of English Hay and Vetch and Oats compared.

Dry Matter.	English Hay.	Vetch and Oats.
Crude ash,	6.58	10.65
" cellulose,	30.33	35.95
" fat,	3.48	2.61
" protein,	11.10	13.42
Nitrogen-free extract,	48.51	37.37
	100.00	100.00

Digestibility.

The percentages of digestibility of the different ingredients in each of the above hays are the results of actual estimations at this station.

Coefficients of Digestibility.

	English Hay.	Vetch and Oats.
Crude cellulose,	60	66
" fat,	49	19
" protein,	60	58
Nitrogen-free extract,	60	54

Pounds of Digestible Matter in 2,000 Pounds of the Perfectly Dry Hays.

English hay,	1,113
Vetch and oats,	1,043

It will thus be seen that the vetch and oats furnish very nearly as much digestible matter in a ton as an extra quality of hay. The digestible protein in the vetch and oats is fully one per cent. higher than in the hay.

The hay grown upon the station grounds is of extra quality, having a considerable sprinkling of clover, and showing at best two per cent. more protein than the average hay grown upon New England farms.

Vetch and oats has the advantage over peas and oats in that the vetch stands up much better, and can be easily cut with a mowing machine. To secure the best results, the crops should be cut when in early to middle bloom. If cut when in late bloom the oats will have developed a considerable amount of woody fibre, rendering them less palatable and digestible.

V.

THE BABCOCK vs. THE "SPACE" SYSTEM, AS A BASIS FOR PAYMENT IN MASSACHUSETTS CREAMERIES.

BY J. B. LINDSEY.

By the Babcock system is meant the weighing of each patron's daily cream, raised or separated by whatever process, taking a fair sample of it, with a suitable sampler, preserving the daily samples, and once in ten days to two weeks testing this average sample for the percentage of butter fat by means of the Babcock tester. The percentage of butter fat found, multiplied by the pounds of cream, gives the pounds of butter fat actually in the cream.

The directors of the creamery, having a certain sum of money to divide, and knowing the total number of pounds of butter fat collected, divide the former amount by the latter; the quotient resulting represents the *price per pound* to be paid for the butter fat. The value of a pound of butter fat for the month having been in this way determined, is multiplied by the pounds of butter fat furnished by the patron, and the product represents the money he is entitled to each month for his cream. By this method the value of the cream is based entirely upon its content of butter fat.

The space system is familiar to all. The milk in deep-setting cans is submerged in ice water, and after a certain time the number of spaces of cream on each can is read by means of a strip of graduated glass set in the side of the can. A "space" is a circular volume of cream, $\frac{19}{64}$ of an inch thick, and $8\frac{1}{2}$ inches in diameter. It is assumed by those who favor this system that a space of cream has comparatively the same value, no matter from what milk it is raised. A given quantity of poor milk may furnish fewer

spaces than the same quantity of rich milk, it is argued, but the quality of the space would be equally as valuable for butter purposes.

The Babcock test as a basis for payment is used almost exclusively in the West. According to Professor Jordan,* the larger number of Maine creameries are using this system. In Vermont a very large portion of the milk and cream sold is paid for on the basis of butter fat it contains. In Connecticut the creameries are gradually adopting the Babcock system, and the writer has heard of several Massachusetts creameries employing it. Many inquiries have been made during the past year as to the comparative merits of the Babcock and the "space" systems, and the writer thought it advisable, therefore, to make an investigation, and to present the results obtained *as an object lesson* to those interested in this all-important branch of farm industry. Such an investigation had already been made by the Connecticut Experiment Station, and the results published in Bulletin 119. That station has recommended the Babcock system for general use in Connecticut creameries.

The Investigation.

The Cream collected and tested for Butter Fat.

The writer personally accompanied the cream gatherers of a large creamery in this locality, and took as fair a sample as possible of the cream of one hundred and sixty-five different patrons, by means of a small glass rod run into the mixed cream after the milk had been drawn, care being taken to draw off the milk as thoroughly as possible in each case. The sample of cream was run into small numbered glass bottles, and tested for butter fat by the Babcock method on the same day. The weight of the cream was also noted, as well as the number of spaces, and the temperature of the water in the tank. The result of this inquiry is presented in Table I.: —

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* See report of Prof. W. H. Jordan's lecture before Connecticut farmers in "New England Homestead," Feb. 15, 1894.

TABLE I.

Columns —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
1	54	40.00	18.70	7.48	13.86	$1 65	$1 63	—$0 60
2	39	29.50	20.00	5.99	15.35	1 19	1 31	+3 60
3	20	15.00	17.10	2.56	12.80	61	56	—1 50
4	80	61.75	16.90	10.43	13.04	2 44	2 28	—4 80
5	8	6.25	20.00	1.25	15.62	24	27	+ 90
6	28	23.25	15.70	3.65	13.00	85	79	—1 80
7	34	24.25	21.60	5.23	15.41	1 04	1 14	+3 00
8	20	15.00	15.00	2.25	11.25	61	49	—3 60
9	29	22.00	18.10	3.98	13.74	88	87	— 30
10	10	8.50	18.00	1.53	15.30	30	33	+ 90
11	26	20.00	18.90	3.78	14.54	79	82	+ 90
12	57	43.25	17.20	7.44	13.05	1 74	1 62	—3 60
13	8	7.00	16.80	1.17	14.70	24	26	+ 60
14	24	19.00	21.40	4.06	16.98	73	89	+4 80
15	89	69.75	19.80	13.81	15.52	2 71	3 01	+9 00
16	77	57.50	17.80	10.23	13.29	2 35	2 23	—3 60
17	67	52.50	19.00	9.97	14.89	2 04	2 17	+3 90
18	47	37.50	16.70	6.26	13.32	1 43	1 37	—1 80
19	35	26.25	16.00	4.38	12.52	1 07	95	—3 60
20	108	82.75	19.00	15.72	14.56	3 29	3 43	+4 20
21	67	53.25	19.60	10.44	15.57	2 04	2 28	+7 20
22	51	38.00	20.20	7.68	15.04	1 56	1 68	+3 60
23	48	39.00	16.70	6.51	13.56	1 46	1 42	—1 20
24	68	47.75	19.70	9.40	13.82	2 07	2 05	— 60
25	28	23.00	20.20	4.65	16.60	85	1 01	+4 80
26	37	27.50	20.20	5.55	15.00	1 13	1 21	+2 40
27	42	33.00	18.50	6.10	14.54	1 28	1 33	+1 50
28	32	24.50	17.10	4.19	13.10	98	91	—2 10
29	14	14.25	14.60	2.08	14.80	43	45	+ 60
30	22	19.50	17.10	3.33	15.16	67	73	+1 80
31	15	11.25	18.50	2.08	13.87	46	45	— 30
32	29	22.75	17.10	3.89	13.42	88	85	— 90

TABLE I. — *Continued.*

COLUMNS —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
33	24	19.25	18.2	3.53	14.71	$0 73	$0 77	+$1 20
34	25	21.25	19.3	4.10	16.40	76	89	+3 90
35	37	30.25	19.3	5.83	17.58	1 13	1 27	+4 20
36	182	126.75	17.2	21.80	12.00	5 55	4 76	—23 70
37	70	50.50	18.5	9.34	13.34	2 14	2 04	—3 00
38	48	35.50	19.1	6.84	14.24	1 46	1 49	+ 20
39	24	16.50	21.6	3.62	15.18	73	79	+1 80
40	28	19.00	18.6	3.53	12.62	85	76	—2 70
41	80	58.63	18.6	10.91	13.63	2 44	2 38	—1 80
42	42	34.00	11.0	3.74	8.90	1 28	82	—13 80
43	64	48.75	20.4	9.94	15.53	1 95	2 17	+6 60
44	35	27.40	19.8	5.46	15.61	1 07	1 19	+3 60
45	30	24.00	20.5	4.92	16.40	92	1 07	+4 50
46	18	15.50	17.2	2.66	15.41	55	58	+ 90
47	23	18.75	14.4	2.73	11.87	70	60	—3 00
48	41	32.25	18.3	5.90	14.39	1 25	1 29	+1 20
49	35	27.50	18.3	5.03	14.37	1 07	1 10	+ 90
50	84	66.75	18.3	12.21	14.54	2 56	2 66	+3 00
51	40	31.25	16.2	5.08	12.72	1 22	1 12	—3 00
52	24	22.00	17.3	3.80	15.83	73	83	+3 00
53	29	22.75	17.9	4.02	13.89	88	88	±
54	17	12.50	20.2	2.52	14.85	52	55	+ 90
55	20	15.50	20.4	3.16	15.81	61	69	+2 40
56	26	20.00	19.3	3.86	14.85	79	84	+1 50
57	17	14.75	15.3	2.26	13.27	52	49	— 90
58	24	18.00	20.0	3.60	15.00	73	78	+1 50
59	105	85.63	19.2	16.44	15.66	3 20	3 59	+11 70
60	136	97.50	21.5	20.96	15.41	4 15	4 57	+12 60
61	28	20.00	19.5	3.90	13.93	85	85	±
62	25	20.00	16.0	3.20	12.80	76	70	—1 80
63	14	10.75	18.3	1.97	14.00	43	43	±
64	57	43.50	18.2	7.91	13.88	1 74	1 73	— 30

TABLE I. — *Continued.*

Columns —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
65	21	17.00	18.6	3.16	15.90	$0 64	$0 69	+$1 50
66	24	15.50	19.0	2.94	12.27	73	64	—2 70
67	29	21.50	18.4	3.95	13.64	88	86	— 60
68	17	13.25	17.2	2.27	13.41	52	50	— 60
69	20	15.00	19.1	2.86	14.32	61	62	+ 30
70	14	11.00	17.5	1.92	13.75	43	42	— 30
71	33	22.00	18.6	4.09	12.40	1 01	89	—3 60
72	22	13.50	21.0	2.83	12.89	67	62	—1 50
73	36	32.00	15.3	4.89	13.60	1 10	1 07	— 90
74	26	20.00	20.3	4.06	15.62	79	89	+3 00
75	21	17.00	16.5	2.80	13.35	64	61	— 90
76	47	33.50	20.9	7.00	14.90	1 43	1 53	+3 00
77	30	21.50	17.8	3.82	12.76	92	83	—2 70
78	38	26.50	19.4	5.14	13.53	1 16	1 12	—1 20
79	70	52.75	17.8	9.39	13.41	2 14	2 05	—2 70
80	27	20.50	17.3	3.54	13.13	82	77	—1 50
81	127	94.50	17.6	16.63	13.09	3 87	3 63	—7 20
82	31	21.25	20.2	4.29	13.85	95	94	— 30
83	9½	6.00	19.6	1.17	12.38	29	26	— 90
84	31	24.00	19.0	4.56	14.71	95	1 00	+1 50
85	7	5.00	19.2	0.96	13.71	21	21	±
86	17	12.50	22.0	2.75	16.18	52	60	+2 40
87	49	34.00	18.2	6.18	12.63	1 49	1 35	—4 20
88	22	16.80	17.7	2.97	13.51	67	65	— 60
89	39	32.00	15.0	4.80	12.31	1 19	1 05	—4 20
90	25	20.25	16.4	3.32	13.28	76	72	—1 20
91	28	22.50	16.7	3.75	13.42	85	82	— 90
92	29	25.00	18.8	4.70	16.21	88	1 03	+4 50
93	29	22.50	16.8	3.78	13.04	88	82	—1 80
94	46	37.75	17.7	6.68	14.52	1 40	1 46	+1 80
95	10	9.25	11.2	1.03	10.36	31	22	—2 70
96	58	46.00	16.9	7.77	13.40	1 77	1 70	—2 10

TABLE I. — *Continued.*

Columns —								
1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
97	42	34.00	18.2	6.19	14.73	$1 28	$1 35	+$2 10
98	58	44.00	20.2	8.89	15.31	1 77	1 94	+5 10
99	28	23.75	18.0	4.27	15.27	85	93	+2 40
100	29	21.50	15.2	3.27	11 27	88	71	—5 10
101	21	18.63	16.4	3.05	14.55	64	67	+ 90
102	38	27.00	17.9	4.83	12.72	1 16	1 05	—3 30
103	9	8.75	15.6	1.36	15.17	27	30	+ 90
104	14	9.75	21.6	2.10	15 00	43	46	+ 90
105	25	16.80	20.2	3.33	13.32	76	73	— 90
106	15	10.25	17.1	1.75	11.68	46	38	—2 40
107	14	12.25	18.2	2.23	15.92	43	49	+1 80
108	56	41.50	18.3	7.59	13.56	1 71	1 66	—1 50
109	61	48.75	17.8	8.68	14.22	1 86	1 89	+ 90
110	14	12.50	17.2	2.15	15 36	43	47	+1 20
111	12	9.00	17.0	1.53	12.75	37	33	—1 20
112	13	10.75	16.4	1.76	13.56	40	38	— 60
113	13	9.75	16.7	1.62	12.52	40	35	—1 50
114	22	15.00	17.0	2.55	11.59	67	56	—2 70
115	12	10.25	16.4	1.68	14.00	37	37	±
116	21	14.50	20.9	3.13	14.93	64	68	+1 20
117	13	9.75	19.5	1.90	14.62	40	41	+ 30
118	19	14.50	21.4	3.10	16.33	58	68	+3 00
119	52	40.75	19.0	7.74	14.89	1 59	1 69	+3 00
120	51	38.00	18.4	6.99	13.71	1 56	1 53	— 90
121	48	35.50	18.8	6.67	13.90	1 46	1 45	— 30
122	51	42.25	17.9	7.56	14.82	1 56	1 66	+3 00
123	10	8.50	16.8	1.43	14.28	31	31	±
124	28	22.50	16.5	3.71	13.26	85	82	— 90
125	9	9.50	16.7	1.58	17.63	27	34	+2 10
126	38	26.50	20.1	5.33	14.02	1 16	1 16	±
127	29	23.00	17.0	3.91	13.48	88	85	— 90
128	38	25.50	17.2	4.39	11.54	1 16	96	—6 00

TABLE I. — *Continued.*

Columns — 1	2	3	4	5	6	7	8	9
Number of Patron	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
129	7	7.25	15.10	1.09	15.64	$0 21	$0 24	+$0 90
130	25	19.25	15.50	2.98	11.93	76	65	—3 30
131	15	11.00	17.50	1.92	12.83	46	42	—1 20
132	8	7.75	15.80	1.22	15.31	24	27	+ 90
133	11	9.00	15.00	1.35	12.27	34	29	—1 50
134	12	10.00	17.40	1.74	14.50	37	38	+ 30
135	10	8.50	14.10	1.19	11.98	31	26	—1 50
136	7	5.25	16.30	0.86	12.22	21	19	— 60
137	41	32.25	17.80	5.74	14.00	1 25	1 26	+ 30
138	10	8.25	17.60	1.45	14.52	31	32	+ 30
139	15	13.50	14.50	1.96	13.05	46	43	— 90
140	11	9.50	14.50	1.37	12.52	34	30	—1 20
141	13	10.25	16.20	1.66	12.77	40	36	—1 20
142	11	8.50	18.00	1.53	13.91	34	33	— 30
143	43	34.63	17.80	6.14	14.29	1 31	1 34	— 90
144	35	29.50	15.70	4.63	13.23	1 07	1 01	—1 80
145	54	41.50	19.60	8.13	15.04	1 65	1 78	+3 90
146	56	42.00	19.50	8.19	14.63	1 71	1 79	+2 40
147	18	14.00	17.50	2.45	13.61	55	53	— 60
148	24	19.75	17.80	3.51	14.23	73	77	+1 20
149	30	26.00	17.20	4.47	13.91	92	98	+1 80
150	26	19.50	18.10	3.53	13.58	79	77	— 60
151	35	26.75	19.60	5.24	14.98	1 07	1 14	+2 10
152	6	3.50	18.80	0.66	10.97	18	14	—1 20
153	36	26.00	18.00	4.68	13.00	1 10	1 02	—2 40
154	62	45.50	18.80	8.55	13.79	1 89	1 87	— 60
155	18	15.50	16.40	2.54	14.12	55	55	±
156	18	13.50	17.95	2.42	13.46	55	53	— 60
157	16	12.50	19.00	2.37	14.84	49	52	+ 90
158	19	18.00	14.40	2.59	13.64	58	56	— 60
159	22	16.00	19.40	3.10	14.11	67	68	+ 30
160	26	18.50	18.00	3.33	12.69	79	73	—1 80

TABLE I. — *Concluded.*

1	2	3	4	5	6	7	8	9
Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Fat in 100 Spaces of Cream.	Value of Cream at 3.05 Cents per Space.	Value of Cream by Babcock Test at 21.83 Cents per Pound Butter Fat.	Payment by Babcock Test would give + or — than by Space System for 30 Days.
161	21	16.5	12.80	2.11	10.06	$0 64	$0 46	—$5 40
162	51	37.0	19.60	7.25	14.22	1 56	1 59	+ 90
163	55	44.5	15.70	6.98	12.70	1 68	1 53	—4 50
164	55	46.5	18.00	8.37	15.22	1 68	1 83	+4 50
165	37	28.5	18.80	5.36	14.48	1 13	1 17	+1 20
	5,659	-	-	790.77	-	$172 61	$172 60	-

Comments on Table I.

Column 1 represents the number of each patron; column 2, the number of spaces; column 3, the pounds of cream; column 4, the per cent. of fat in cream; column 5, the pounds of fat actually furnished by each patron in one day's cream. Column 6, showing the pounds of butter fat in 100 spaces of each patron's cream, is calculated for the sake of comparison. Column 7 represents the value of the cream at the price per space paid by the creamery at the time. Column 8 shows the value of the cream by Babcock test, on the basis of 21.83 cents per pound of butter fat. This value per pound of fat was determined by taking the value of the cream as represented by the space system, and dividing it by the number of pounds of butter fat actually found in the cream. The quotient showed the price per pound of butter fat. Column 9 shows whether payment by the Babcock test would be more or less than by the space system for thirty days.

It will be seen that the percentage of fat in the cream varies very much. The extremes are 11 and 22 per cent.

The pounds of butter fat in 100 spaces of each patron's cream differ also widely, the extreme being 8.90 pounds and 17.63 pounds.

Attention is also called to the last column, which makes emphatic that by the Babcock system those patrons furnishing the better to best qualities of cream would be paid more, and those furnishing the poorer qualities would be paid less, than by the present system.

Summary of Table I., showing Butter Equivalent from 100 Spaces of Graded Cream, and Value of Same.

Pounds of Butter Fat from 100 Spaces of Cream.	Number of Patrons.	Per Cent. of Patrons.	Equivalent to Butter. — Pounds.	Value of Butter at 25 Cents per Pound.
8-12, ...	10	6.1	13.42*	$3 35
12-13, ...	23	14.0	14.58	3 64
13-14, ...	52	31.5	15.75	3 94
14-15, ...	41	24.9	16.92	4 23
15-16, ...	30	18.2	18.08	4 52
16-18, ...	9	5.5	19.83	4 96

* Figured on the basis of 11.5 pounds of butter fat.

This summary gives us at least a comparative idea of the different qualities of cream furnished, and their approximate values in butter. It brings out the variations in a very striking manner, and needs no further explanation.

Is the Weight of the "Space" Constant?

In order to show the variations, the weight per space of the cream collected from thirty-six different patrons on two consecutive days is given in Table II. Beginning from the left, each fraction of a pound shows the weight of a space of each patron's cream.

TABLE II.

First Day.

	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Patrons 1-9, ...	.713	.948	.682	.785	.802	.833	.662	.695	.714
" 10-18, ...	.840	.760	.768	.750	.705	.685	.775	.704	.758
" 19-27, ...	.766	.743	.786	.788	.809	.716	–	.720	.773
" 28-36, ...	.800	.971	.875	.725	.785	.765	.862	.792	.709

Average weight of a space, ...750 pounds.

TABLE II. — *Concluded.*

Second Day.

	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Patrons 1-9, ...	.741	.756	.750	.772	.781	.830	.713	.750	.758
" 10-18, ...	.850	.770	.759	.875	.791	.783	.747	.784	.798
" 19-27, ...	.750	.766	.795	.745	.813	.702	.822	.743	.786
" 28-36, ...	.766	1.020	.887	.750	.785	.802	.850	.818	.696

Average weight of a space, ...766 pounds.

Comments on Table II.

Having noted in Table I. the data, showing the wide differences existing in the *composition* of the space as furnished by different patrons, one has only to examine Table II. to note equally as wide differences in the *weight* of the space. One could not fail to note these differences when weighing the different lots of cream, twenty-five spaces from one patron often showing a different weight from a like amount furnished by another.

Is the Babcock test reliable?

Can a pound of butter always be made from the same number of spaces?

In order to illustrate these points, the cream of three patrons was churned separately. No. 1 was a poor cream, No. 2 a good cream and No. 3 a cream of fair quality. The cream was weighed, the number of spaces noted, as well as the per cent. of butter fat it contained. The butter produced from each cream was also weighed, as well as the buttermilk, and tested for the per cent. of butter fat. The per cent. of water in each of the different samples of butter was also determined.

TABLE III. — *Showing Results of the Test.*

NUMBER.	Number of Spaces.	Weight of Cream (Pounds).	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Butter made.	Per Cent. of Fat in Butter.	Pounds of Fat in Butter.	Pounds Buttermilk.	Pounds Fat in Buttermilk.	Total Fat in Butter and Buttermilk.
1, ...	17	14	12.0	1.68	2.50*	61.45	1.53	17.5	0 14	1.67
2, ...	25	17.5	20.4	3.57	4.50	76.73	3.45	15.0	0.05	3 50
3, ...	25	19.5	17.0	3.32	4.25	75.30	3.20	33.5	0.03	3.23

* Not salted, but equal to about 2.60 pounds salted butter.

The above table shows the reliability of the Babcock test. Please notice that in the cream churned there were 1.68, 3.57 and 3.32 pounds of butter fat respectively, and we accounted for by means of this test 1.67 pounds, 3.50 pounds and 3.23 pounds. In the process of manipulation small fractions are of course lost; the results, however, tally very closely, and as near as one could expect or ask for.

Composition of the Butter.

	No. 1.*	No. 2.	No. 3.
Water, ...	31.85	13.61	17.80
Fat, ...	58.48	76.73	75.30
Salt and curd, ...	9.67	9.67	6.90

* Calculated on salt and curd basis of No. 2; this butter was not salted.

Attention is called to the very large amount of water in No. 1, and the consequent low percentage of butter fat. The butter maker reported that it was impossible to work out more water. The butter had a very inferior appearance. Numbers 2 and 3 looked well.

Spaces to the Pound.

(a) Butter Maker's Report.

	I.	II.	III.
Spaces per pound salted, . . .	6.41	5.55	5.88

(b) On the Basis of Same Amount of Water as found in No. II.

Spaces per pound salted, . . .	8.29	5.55	6.19

These results make very clear that, other things being equal, the number of spaces required to make a pound of butter of *like water content* depends entirely upon the amount of butter fat in the cream; and it is very strange that farmers will be so blind to their own interest as to fail to recognize this fact. Cream will make butter *in proportion to the amount of butter fat it contains.*

Conclusions.

The results obtained fully confirm the investigations made along this line elsewhere.

They show conclusively that the space of cream is of very variable composition, and is not a true measure of the value of cream for butter purposes. The value of cream for butter, other things being equal, depends entirely upon the amount of butter fat it contains. The number of spaces of cream required to make a pound of butter depends also upon the butter fat content of the cream.

The Babcock test is perfectly reliable, and this system can be applied practically to determine the value of cream raised by the deep-setting process.

VI.

I. FIFTH FEEDING EXPERIMENT WITH STEERS.

By J. B. Lindsey.

1893–94.

General Description.

The experiment here described is a continuation of those published in our previous reports.

Three grade Durham steers, yearlings, weighing about 600 pounds each, were used in the experiment. They were quite thin when first received, and cost 3 69 cents per pound live weight.

The coarse foods fed were raised upon the station grounds, and consisted principally of corn ensilage, corn stover, vetch and oats and a variety of green crops with some roots. The corn for ensilage was cut just as the kernels were glazing. The corn stover was the corn plant remaining after the fully matured ears had been removed. The grains fed were wheat bran, Buffalo gluten feed, new-process linseed meal, corn and cob meal, cotton-seed meal and oat feed. The quantity of coarse fodders fed depended in all cases upon the individual appetite of the animals

The animals were fed and watered twice each day, between six and seven o'clock in the morning and at five in the afternoon, one-half of the food being given at each time. About one ounce of salt was added to the grain feed daily. Whenever the weather permitted, the steers were allowed the use of the barn-yard for at least one-half a day. They were kept well carded.

The weights of the animals were taken weekly, before being watered in the morning.

The Reasons for the Experiment.

I. To note the effect of distinct fodder rations upon the production of live weight.

II. To secure facts relating to the actual cost of beef production in Massachusetts under existing local conditions.

III. To compare the relative merits and cost of pasture *vs.* soiling during the summer season.

I. Effect of Distinct Fodder Rations upon the Production of Live Weight.

Average Composition of the Daily Fodder Rations (1893–94).

I. *May 16 to June 8.*

Buffalo gluten feed,	3.00 lbs.
New-process linseed meal,	2.00 "
Soja-bean and corn ensilage,	39.38 "
Nutritive ratio,	1 : 5.51
Total cost,	10.86 cts.
Manurial value obtainable,	6.99 "
Net cost,	3.87 "

II. *June 21 to July 4.*

Buffalo gluten feed,	3.00 lbs.
New-process linseed meal,	2.00 "
Rowen,	14.00 "
Nutritive ratio,	1 : 4.64
Total cost,	15.95 cts.
Manurial value obtainable,	9.32 "
Net cost,	6.63 "

III. *November 7 to November 20.*

Wheat bran,	3.00 lbs.
New-process linseed meal,	3.00 "
Corn stover,	15.33 "
Nutritive ratio,	1 : 6.29
Total cost,	10.57 cts.
Manurial value obtainable,	10.18 "
Net cost,	0.39 "

IV. *November 28 to January 2.*

Wheat bran,	3.00 lbs.
New-process linseed meal,	3.00 "
Corn stover,	12.07 "
Roots,*	15.00 "
Nutritive ratio,	1 : 6.10
Total cost,	12.75 cts.
Manurial value obtainable,	10.45 "
Net cost,	2.30 "

V. *January 27 to February 11.*

Buffalo gluten feed,	4.00 lbs.
Oat feed,	4.00 "
Corn stover,	4.00 "
Corn ensilage,	28.91 "
Turnips,	15.00 "
Nutritive ratio,	1 : 8.73
Total cost,	15.49 cts.
Manurial value obtainable,	10.61 "
Net cost,	4.88 "

VI. *March 1 to March 27.*

Cotton-seed meal,	4.00 lbs.
Corn and cob meal,	4.00 "
Corn stover,	4.00 "
Corn ensilage,	42.39 "
Nutritive ratio,	1 : 6.25
Total cost,	15.30 cts.
Manurial value obtainable,	10.10 "
Net cost,	5.20 "

* Potatoes or mangolds.

Summary of Cost of the Average Daily Fodder Rations.

[Cents.]

	Feeding Periods.					
	I.	II.	III.	IV.	V.	VI.
Total cost,	10.86	15.95	10.57	12.75	15.49	15.30
Manurial value obtainable,*	6.99	9.32	10.18	10.45	10.61	10.10
Net cost,	3.87	6.63	0.39	2.30	4.88	5.20
Gain required per Day in Pounds of Live Weight to cover Cost of Feed.						
Total cost,	2.82	4.14	2.74	3.31	4.02	4.00
Net cost,	1.00	1.72	0.10	0.60	1.27	1.35
Live Weight actually produced per Day.						
	1.50	0.88	0.93	0.95	1.87	0.81
Cost of Feed per Pound of Live Weight gained.						
Total cost,	7.24	18.01	11.36	13.42	8.29	18.88
Net cost,	2.56	7.53	0.43	2.42	2.61	6.42

* Allowing 90 per cent. of the fertilizing ingredients to be recovered in the manure.

The periods in which ensilage was fed as the coarse fodder produced distinctly the largest gains in live weight. The hay ration (Period II.) was the most costly one.

II. What it has cost to produce Beef.

Below is presented a detailed account of the cost of the foods consumed. The cost of labor, interest on the money involved, etc., is not added.

The steers were purchased March 28, 1893, at 3.69 cents per pound live weight, and were sold April 4, 1894, for 3.85 cents per pound live weight. It is to be noted that these animals were bought when beef was high and of necessity sold when it was low, which will naturally not be favorable to a successful financial operation. They were soiled during the summer of 1893.

The three steers consumed nearly the same amount of food, only slight differences being noted in the coarse fodders.

Record of Feed consumed.

[Average.*]

FODDER ARTICLES.	Feed consumed (Pounds).	Dry Matter (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Wheat bran,	675	600.75	$6 41	$3 98	$2 43
Buffalo gluten feed,	476	437.92	4 52	2 70	1 82
New process linseed meal,	705	630.13	9 52	7 47	2 05
Cotton-seed meal,	168	154.56	2 26	2 13	13
Corn and cob meal,	161	123.97	1 45	47	98
Oat feed,	96	89.28	91	34	57
Rowen,	869	770.80	6 51	3 37	3 14
Soja-bean and corn ensilage,	2,569	570.03	3 52	2 04	1 48
Corn ensilage,	2,725	572.20	3 41	1 42	1 99
Corn stover,	1,256	954.56	3 13	3 77	64
Corn fodder,	314	59.66	39	14	25
Vetch and oats,	552	138.00	76	47	29
Buckwheat,	1,389	208.35	1 74	1 33	41
Cabbage,	1,200	156.00	1 50	1 34	16
Other green crops,	1,652	330.00	2 07	1 49	58
Turnips and potatoes,	735	90.00	92	40	52
Beets,	615	100.24	1 23	50	73
	–	6,746.45	$50 25	$33 36	$16 89

* The steers consumed approximately the same quantities of food during the entire experiment, only slight difference in coarse fodders being noted.

Steer I.

	Pounds.
Live weight of animal when purchased,	557.00
Live weight of animal when sold,	1,107.00
Total gain during experiment,	550.00
Average gain in weight per day,	1.47
Dry matter required to produce one pound live weight,	12.26

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$20 55	–
Total cost of feed,	50 25	–
Selling price of steer, 1,107 pounds, at 3.85 cents.	–	$42 61
Value of manure produced,	–	33 36
	$70 80	$75 97

	Cents.
Total cost of feed per pound live weight actually produced,	9.14
Net cost of feed per pound live weight actually produced,	3.07
Total cost to us of one pound live beef,	6.39

Steer II.

	Pounds.
Live weight of animal when purchased,	517.00
Live weight of animal when sold,	1,045.00
Total gain during experiment,	528.00
Average gain in weight per day,	1.41
Dry matter required to produce one pound live weight,	12.78

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$19 08	–
Total cost of feed,	50 25	–
Selling price of steer, 1,045 pounds, at 3.85 cents.	–	$40 23
Value of manure produced,	–	33 36
	$69 33	$73 59

	Cents
Total cost of feed per pound live weight actually produced,	9.52
Net cost of feed per pound live weight actually produced,	3.20
Total cost to us of one pound live beef,	6.63

Steer III.

	Pounds.
Live weight of animal when purchased,	550.00
Live weight of animal when sold,	1,137.00
Total gain during experiment,	587.00
Average gain in weight per day,	1.57
Dry matter required to produce one pound live weight,	11.49

Financial Statement.

	Debit.	Credit.
Original cost of steer,	$20 30	–
Total cost of feed,	50 25	–
Selling price of steer, 1,137 pounds, at 3.85 cents.	–	$43 77
Value of manure produced,	–	33 36
	$70 55	$77 13

	Cents.
Total cost of feed per pound live weight actually produced,	8.57
Net cost of feed per pound live weight actually produced,	2.87
Total cost to us of one pound live beef,	6.20

Summary of Three Steers.

	Pounds.
Live weight of animals when purchased,	1,624.00
Live weight of animals when sold,	3,289.00
Total gain during experiment,	1,665.00
Average gain in weight per day,	1.48
Dry matter required to produce one pound live weight,	12.32

Financial Statement.

	Debit.	Credit.
Original cost of steers,	$59 93	–
Total cost of feed,	150 75	–
Selling price of steers,	–	$126 61
Value of manure produced,	–	100 08
	$210 68	$222 69

	Cents.
Total cost of feed per pound live weight actually produced,	9.08
Net cost of feed per pound live weight actually produced,	3.04
Total cost to us of one pound live beef,	6.41
Net cost to us of one pound live beef,	3.36

The total cost of the 3,289 pounds of live beef actually sold was 6.41 cents per pound, and the net cost, found by deducting the manure reckoned at a maximum value, is 3.36 cents. The steers were sold at 3.85 cents per pound live weight. The animals gained 1.48 pounds live weight daily during the entire experiment. We hardly think it possible to secure better results with the average grade steer. The results, however, make an unfavorable financial showing. (See discussion of results in the general summary of steer-feeding experiments.)

III. Summer Soiling *vs.* Pasture.

This experiment was an exact repetition of the one described in the report for 1893.

The three steers were kept in the barn or turned into the barn-yard during the summer and fall months, and fed upon a variety of green crops raised upon the station grounds in combination with various grains.

Feed consumed by Each Steer during Summer Soiling.

[As the different steers consumed practically the same amount of feed, one statement for the three will suffice.]

Fodder Articles.	Feed Consumed (Pounds).	Local Market Cost.	Manurial Value Obtainable.	Net Cost.
Buffalo gluten feed,	253.50	$2 40	$1 43	$0 97
New-process linseed meal,	367.00	4 95	3 89	1 06
Wheat bran,	205.50	1 95	1 21	74
Soja-bean and corn ensilage,	160.70	2 20	1 27	93
Rowen,	677.00	5 07	2 62	2 45
Vetch and oats (green),	552.00	76	47	29
Other green crops,	1,442.00	1 80	1 30	50
Buckwheat,	1,389.00	1 74	1 33	41
Corn fodder,	314.00	39	14	25
Cabbages,	800.00	1 00	90	10
	-	$22 26	$14 56	$7 70

Summer Soiling compared with Pasture.

	Summer Soiling.			Pasture.		Pasture.	Soiling.
	Steer I.	Steer II.	Steer III.	Average Two Steers. 1890.	Average Three Steers. 1891.	Average Five Steers.	Average Three Steers.
Date of beginning experiment,	May 1,	May 1,	May 1,	May 10,	April 27,	-	-
Date of ending experiment,	Sept. 30,	Sept. 30,	Sept. 30,	Sept. 30,	Nov. 3,	-	-
Number of days,	153	153	153	144	190	-	-
Live weight of steers at beginning of experiment (pounds),	578	552	630	867	828	-	-
Live weight of steers at end of experiment (pounds),	880	912	835	971	935	-	-
Total weight gained (pounds),	302	360	205	104	107	106	289
Average gain in weight per day (pounds),	1.97	2.35	1.34	0.72	0.57	0.63	1.89
Total cost of feed per day, soiling (cents),	14.55	14.55	14.55	-	-	-	14.55
Net cost of feed per day, soiling (cents),	5.03	5.03	5.03	-	-	-	5.03
Total cost of feed per day at 40 cents per week for pasture (cents),	-	-	-	5.71	3.57*	4.64	-
Total cost of feed required to produce one pound of live weight (cents),	7.38	6.19	10.85	8.24	6.36	7.30	8.14
Net cost of feed required to produce one pound of live weight (cents),	2.55	2.14	3.76	-	-	-	2.82

* Allowing 25 cents per week for pasture.

The results make as good if not a better showing than those reported last year. The comparative merits of soiling *vs.* pasture are briefly discussed in the general summary of steer-feeding experiments.

Additional Data of the Experiment.

Local Market Cost, per Ton, of the Various Articles of Fodder.

Wheat bran,	$19 00
Buffalo gluten feed,	19 00
New-process linseed meal,	27 00
Oat feed,	19 00
Cotton-seed meal,	27 00
Corn and cob meal,	18 00
English hay,	15 00
Vetch and oats (dry),	15 00
Rowen,	15 00
Corn and soja-bean ensilage,	2 75
Turnips,	2 50
Potatoes,	2 50
Mangolds,	4 00
Corn stover,	5 00
Corn ensilage,	2 50
Other green crops,	2 50

Analyses of Fine Feeds.

Fodder Analyses.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Oat Feed.	Cotton-seed Meal.	Corn and Cob Meal.
Moisture at 100° C.,	11.00	8.00	10.62	7.00	9.00	23.00
Dry matter,	89.00	92.00	89.38	93.00	91.00	77.00
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude ash,	8.00	1.00	5.89	4.61	7.10	1.64
" cellulose,	11.00	7.00	8.84	17.73	5.53	7.54
" fat,	5.00	14.30	3.94	3.95	9.66	4.19
" protein,	18.00	23.60	40.79	11.02	50.34	10.00
Nitrogen free extract,	58.00	54.10	40.54	62.69	27.37	76.63
	100.00	100.00	100.00	100.00	100.00	100.00

Fertilizing Constituents.

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

Fertilizer Analyses.	Wheat Bran.	Buffalo Gluten Feed.	New-process Linseed Meal.	Oat Feed.	Cotton-seed Meal.	Corn and Cob Meal.
Moisture,	11.00	8.00	10.62	7.00	8.00	23.00
Nitrogen,	2.55	3.47	5.83	1.63	6.88	1.23
Phosphoric acid,	2.46	0.35	1.95	1.25	2.37	0.70
Potassium oxide,	1.58	0.10	1.08	0.80	1.70	0.40
Valuation per 2,000 pounds,	$13 12	$12 14	$23 53	$7 83	$32 24	$5 44
Manurial value obtainable,	11 81	11 34	21 18	7 05	29 00	4 90

Analyses of Coarse Fodder Articles.

[Per Cent.]

Fodder Analyses.	Rowen.	Corn and Soja-bean Ensilage.	Corn Ensilage.	Corn Stover.	Turnips.	Potatoes.	Mangolds.
Moisture at 100° C.,	11.30	77.77	79.00	24.00	90.00	78.67	83.71
Dry matter,	88.70	22.23	21.00	76.00*	10.00	21.33	16.29
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.							
Crude ash,	6.48	9.48	4.53	7.14	8.83	4.76	6.79
" cellulose,	30.00	26.63	33.30	33.38	11.75	2.30	5.84
" fat,	4.23	3.75	4.28	1.59	1.68	0.62	0.71
" protein,	12.11	7.91	6.31	9.91	10.37	9.56	13.27
Nitrogen-free extract,	47.18	52.23	51.58	47.98	67.37	82.76	73.39
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Eighty-three per cent. dry matter during January, February and March.

Fertilizing Constituents.

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

Fertilizer Analyses.	Rowen.	Corn and Soja-bean Ensilage.	Corn Ensilage.	Corn Stover.	Turnips.	Potatoes.	Mangolds.
Moisture,	11.30	77.77	79.00	20.00	90.00	78.67	83.71
Nitrogen,	1.72	0.32	0.21	1.27	0.16	0.33	0.35
Phosphoric acid,	0.46	0.12	0.03	0.30	0.12	0.13	0.11
Potassium oxide,	1.97	0.48	0.41	1.70	0.38	0.59	0.46
Valuation per 2,000 pounds,	$8 64	$1 77	$1 17	$6 67	$0 96	$1 94	$1 82
Manurial value obtainable,	7 77	1 59	1 05	6 00	86	1 75	1 64

Fertilizing Constituents of "Other Green Crops."

[Per Cent.]

[Nitrogen 17½ cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound.]

Fertilizer Analyses.	Vetch and Oats.	Buckwheat.	Cabbages.	Corn Fodder.	Other Green Crops.
Moisture,	75.00	85.00	87.00	81.00	80.00
Nitrogen,	0.44	0.44	0.53	0.18	0.43
Phosphoric acid,	0.13	0.09	0.21	0.15	0.15
Potassium oxide,	0.42	0.54	0.39	0.33	0.35
Valuation per 2,000 pounds,	$2 13	$2 15	$2 50	$1 01	$2 00
Manurial value obtainable,	1 70	1 93	2 25	90	1 80

The various leguminous and non-leguminous crops above referred to were fed in small quantities, and it has only been possible to attempt an approximate manurial value.

2. GENERAL SUMMARY OF FEEDING EXPERIMENTS WITH GROWING STEERS.

By J. B. Lindsey.

1890–94.

A series of feeding experiments with growing steers has been carried on at the station since December, 1890, and the details published in the successive annual reports. The last experiment was completed in April, 1894. It seems proper at this time to attempt to present a *general summary* of the results obtained.

The steers experimented with during these four to five years were ten in number, of which seven were grade Shorthorns and three grade Durhams. They were generally bought in the autumn, and weighed about 600 pounds each. These were termed "yearlings." At the beginning of the second winter season they had increased to about 1,000 pounds weight, and were termed "two-year-olds." There was one exception in case of the three steers fed during 1893; these were purchased in the spring of 1893, soiled during the summer and sold in the spring of 1894. Five of the steers were pastured during the summer and five were soiled.

Among the questions to which answers were sought were the following: —

I. What are the most economical fodder rations for beef production?

II. The actual cost of beef production in Massachusetts under existing local conditions.

III. The average daily gain in live weight during an entire experiment.

IV. Dry matter required to produce one pound of live weight.

V. The relative merits and cost of pasture *vs.* soiling during the summer season.

Results of the Experiment.

The Most Economical Rations for Beef Production.

Yearlings.

Articles of Fodder.	Average Daily Gain in Live Weight (Pounds).			
	1889-90.	**1890-91.**	**1891-92.**	Average.
Grain and corn stover,	1.30*	–	0.75	1.03
Grain and corn ensilage,	2.92	1.40	1.55	1.96
Grain and corn fodder,	1.55*	–	–	1.55
Grain, corn stover and sugar beets,	0.78	–	–	0.78
Grain, hay and roots,	–	1.49	2.04	1.76

* More than the ordinary amount of grain.

Digestible Matter in Above Rations.

Articles of Fodder.	Digestible Matter consumed Daily per 1,000 Pounds Live Weight (Pounds).				
	Organic Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Grain and corn stover,	9.95	1.69	7.81	0.43	1:5.20
Grain and corn ensilage,	13.96	2.56	10.60	0.85	1:5.10
Grain and corn fodder,	13.63	2.47	10.56	0.60	1:4.90
Grain, corn stover and sugar beets,	11.15	2.13	8.54	0.48	1:4.60
Grain, hay and roots,	13.52	2.49	10.42	0.59	1:5.00
Wolff's standard,	15.08	2.17	12.54	0.37	1:6.25

Two-year-olds.

Articles of Fodder.	Average Daily Gain in Live Weight (Pounds).					
	1889-90.	**1890-91.**	**1891-92.**	**1892-93.**	**1893-94.**	Average.
Grain and corn stover,	–	–	–	0.98	0.93	0.95
Grain and corn ensilage,	3.84	1.57	1.44	1.84	1.15	1.97
Grain, hay and straw,	–	1.61	–	–	–	1.61
Grain, hay and roots,	–	1.65	1.15	–	–	1.40

Digestible Matter in Above Rations.

Articles of Fodder.	Digestible Matter consumed Daily per 1,000 Pounds Live Weight (Pounds).				
	Organic Matter.	Protein.	Carbo-hydrates.	Fat.	Nutritive Ratio.
Grain and corn stover,	10.27	1.53	8 36	0.38	1:6.2
Grain and corn ensilage,	11.89	1.94	9.22	0.70	1:5.6
Grain, hay and straw,	13.27	2.61	9.93	0.72	1:4.5
Grain, hay and roots,	11.94	2.18	9.24	0.51	1:5.0

Summary of Cost of the Average Daily Fodder Rations.

Yearlings.

Articles of Feed.	Total Cost.	Net Cost.
	Cents.	Cents.
Grain and corn stover,	10.06	3.86
Grain, corn stover and sugar beets,	14.98	7.54
Grain and corn ensilage,	13.47	5.96
Grain and corn fodder,	12.45	4.80
Grain, hay and roots,	15.92	8.83

Two-year-olds.

Grain and corn stover,	9.98	2.12
Grain and corn ensilage,	15.81	6.92
Grain, hay and straw,	16.78	6.85
Grain, hay and roots,	22.63	12.79

Cost of Feed per Pound of Live Weight gained.

Yearlings.

Articles of Feed.	Total Cost.	Net Cost.
	Cents.	Cents.
Grain and corn stover, ...	9.77	3.14
Grain, corn stover and sugar beets, . . .	19.20	9.66
Grain and corn ensilage, ...	6.87	2.10
Grain and corn fodder, ...	8.04	3.10
Grain, hay and roots, ...	9.05	5.02
Two-year-olds.		
Grain and corn stover, ...	10.50	2.23
Grain and corn ensilage, ...	8.02	3.51
Grain, hay and straw, ...	10.42	4.25
Grain, hay and roots, ...	16.16	9.13

What the Above Tables teach.

(*a*) *Relative Average Gain.*

The chief coarse fodders fed were corn stover, corn fodder, corn ensilage and hay and roots. It is to be observed that in case of both yearlings and two-year-olds the *greatest daily gain* was made when the coarse fodder consisted of corn ensilage. Corn fodder and hay and roots also made a very fair showing. In comparing the table of growth and digestible matter consumed it will be observed that a very close relation exists between them. The more digestible matter consumed, the greater the daily gain. Thus in the case of both yearlings and two-year-olds in 1889–90 the gain in live weight during the ensilage period was exceptionally high.

On referring to the tables published in the annual report for 1892, page 166, it will be seen that the steers consumed a very large amount of food during that time, and to this

large food consumption must be attributed the large gain in weight. In case of corn stover as a coarse feed the gain with one exception was small, being about nine-tenths of a pound daily. This is due without doubt to the fact that the total amount of digestible matter consumed during the corn-stover period was relatively small. Corn stover, when fed as a part of the daily coarse fodder ration, makes a valuable food, but when given as a coarse feed exclusively the animals will not consume a quantity sufficient to produce the requisite gain. It has not the sweet taste of the hay, nor the sour, appetizing taste of the ensilage.

On comparing the daily gains with the amount of digestible matter consumed daily, it must be admitted that for an equal amount of digestible matter the corn ensilage rather exceeds all other coarse fodders.

(*b*) *Cost of Daily Gain.*

In comparing the cost of feeds required to produce one pound of live weight, it will be seen that *the relative cost was higher with two-year-olds than with yearlings.* This is in accordance with general teaching.

Again, live weight was produced at the lowest cost both with yearlings and two-year-olds when corn ensilage was the principal coarse fodder of the daily ration. The corn fodder ration is the next higher in cost, and then follow the corn stover and finally, as the highest, the hay ration. When the net cost of feed per pound of live weight gained is considered, the corn-stover period compares very favorably with the ensilage and corn-fodder periods.

In the grain addition to the coarse fodders the point has been to so combine them as to get from 2 to 2.5 pounds of digestible protein in the daily ration.

I. To produce beef, then, at the lowest cost, grow and feed those coarse fodders that yield the largest returns of digestible matter per acre at the least cost of production. Such coarse fodders are corn ensilage, corn fodder and, when properly fed, corn stover.

II. These coarse fodders must be supplemented with concentrated feeds, so as to secure 2 to 2.5 pounds of digestible

protein per 1,000 pounds live weight, thus furnishing a ration having a nutritive ratio of 1 : 5 to 1 : 6.

III. In order to secure maximum growth the rations must be palatable as well as properly balanced.

We have no long feeding periods with green crops excepting corn fodder; but our observations teach that vetch and oats is an excellent economical green fodder. Experiments are in progress to ascertain those green crops that are best suited to our conditions and will give a large yield of palatable fodder.

Daily Fodder Rations for Growing Steers.

Yearlings.

I.		II.	
Buffalo gluten feed,	3 qts.	Wheat bran,	4 qts.
Cotton-seed meal,	1½ "	Buffalo gluten feed,	3 "
Corn stover (dry),	8 lbs.	Corn ensilage,	40 lbs.
Hay,	5 "		
III.		**IV.**	
Chicago gluten meal,	2 qts.	Wheat bran,	4 qts.
Wheat bran,	4 "	New-process linseed meal,	2 "
Corn fodder,	35 lbs.	Green fodder,	40 lbs.

Two-year-olds.

I.		II.	
Buffalo gluten feed,	4 qts.	Wheat bran,	5 qts.
Wheat bran,	5 "	Cotton-seed meal,	2 "
Corn stover,	9 lbs.	Corn ensilage,	50–60 lbs.
Vetch and oats (dry),	7 "		
III.		**IV.**	
Chicago gluten meal,	3 qts.	Corn meal,	4 qts.
Wheat bran,	5 "	New-process linseed meal,	3 "
Corn fodder,	50–60 lbs.	Green fodder,	60 lbs.

The grain feed in the above rations can be used interchangeably with the coarse fodders. They are so combined as to furnish the necessary amount of protein. One must select the various grains with reference to their cost at the time of feeding them.

The Cost of Beef Production.

In the following table will be found a summary of the financial returns from the ten steers.

It will be remembered that five of the steers were pastured during the summer and five were soiled. The object ever has been to combine the feeds so as to get low-cost rations that would at the same time produce maximum growth.

Financial Statement.

	Debit.	Credit.
Original cost of steers, 6,237 pounds, at 3.55 cents,	$221 27	–
Total cost of feed, ...	596 23	–
Selling price of steers, 11,874 pounds, at 3.88 cents,	–	$460 91
Value of manure produced, ...	–	302 53
	$817 50	$763 44

Total gain in live weight, ...	5,637.00 lbs.
Total cost of feed to produce one pound live weight, . .	10.58 cts.
Net cost of feed to produce one pound live weight, . .	5.56 "
Total cost to us of one pound live beef, ...	6.89 "
Net cost to us of one pound live beef, ...	4.34 "
Average gain in weight per day, ...	1.24 lbs.
Dry matter required to produce one pound live weight,* .	11.32 "

* For five steers that were soiled.

Remarks on the Above Figures.

It is to be observed that the above results are not at all encouraging. The first cost of the steers plus the feed consumed amounts to more than the returns from the beef plus the value of manure reckoned at a maximum price.

The cost of feed to produce a pound of live weight has been 10.58 cents, while the total cost to us of a pound of live weight (obtained by adding to the original cost of the steers the cost of the feed consumed, and dividing by the pounds of live weight sold) is 6.89 cents. The net cost to

us of a pound of live beef reckoned in the same way is 4.34 cents. Only by reckoning the manure at a maximum value have we been able to produce live beef at 4.34 cents per pound, the cost of attendance not being included. It must be remembered, however, that our coarse fodders and grains were charged at market rates.

While the results do not present a favorable financial showing, they teach several lessons. In the first place, the writer thinks it would be policy to begin with calves instead of 600-pound steers. The rate of growth of very young stock is much more rapid, and it would be interesting to see if they could not be grown cheaper than they could be purchased. In the second place, more attention must be given to the kind of steer grown. We must have steers that will grow more rapidly than those experimented with. Just as there are good and poor milch cows, so there are good and poor growing steers. Feed, it must be remembered, is only secondary. We must first have the cow bred with a capacity for milk production, and then help her to produce maximum yields by properly feeding her; and in just the same way we must have the steer so bred as to grow rapidly, then, by judicious and economical feeding, seek to get the greatest growth at the minimum cost for feed. The writer believes that by beginning with young calves from animals that have extra reputation for rapid growth, and following a judicious system of feeding, it will yet be possible to produce beef economically in Massachusetts.

Summer Soiling vs. Pasture.

	Summer Soiling.		Pasture.		Average Soiling.	Average Pasture.
	Average Two Steers. 1892.	Average Three Steers. 1893.	Average Two Steers. 1890.	Average Three Steers. 1891.	Average Five Steers.	Average Five Steers.
Date of beginning experiment,	May 1,	May 1,	May 10,	April 27,	-	-
Date of ending experiment,	Sept. 30,	Sept. 30,	Sept. 30,	Nov. 3,	-	-
Number of days,	153	153	144	190	-	-
Live weight of steers at beginning of experiment (pounds),	822	587	867	828	704	847
Live weight of steers at end of experiment (pounds),	1,027	876	971	935	951	953
Total weight gained (pounds),	205	289	104	107	247	106
Average gain in weight per day (pounds),	1.37	1.89	0.72	0.57	1.63	0.63
Total cost of feed per day, soiling (cents),	12.72	14.55	-	-	13.63	-
Net cost of feed per day, soiling (cents),	6.18	5.03	-	-	5.61	-
Total cost of feed per day at forty cents per week for pasture (cents),	-	-	5.71	3.57*	-	4.64
Total cost of feed required to produce one pound live weight (cents),	9.37	8.14	8.24	6.36	8.75	7.30
Net cost of feed required to produce one pound live weight (cents),	4.55	2.82	-	-	3.68	-

* Allowing twenty-five cents per week for pasture.

It will be seen from the above table that the animals soiled made fully two and one-half times the daily gain as did the pasture lots. This is probably due to an abundance of food on the part of the soiled steers. The pastures were what were termed "good" by the average farmer.

The total cost of feed to produce a pound of live weight is about the same in each case. In case of the soiled animals, however, the manure is left upon the farm. If one might assume that the value of the manure from a commercial standpoint would about pay for cost of attendance, the conditions would appear to be about equal. It must not be forgotten, however, that all of the coarse fodders grown upon the place were charged at market rates.

The writer thinks, judging from the above results, that no absolute rule can be laid down to govern all cases. Local conditions and circumstances would undoubtedly be the determining factors. Other things being equal, steers can at least be as economically grown by soiling as by pasturing.

VII.

FEEDING CALVES FOR VEAL.

By J. B. Lindsey.

In our annual report for 1893 was presented an experiment in feeding very young calves with skim-milk alone and with skim-milk combined with various grains. The calves were sold for veal when from seven to ten weeks old. The object was to inquire into the price that could be obtained for the skim-milk per quart when fed to calves and pigs. The results were as follows: —

Calves. — Summary of Results.

1. Price returned per quart for skim-milk, when live weight sells at $4\frac{1}{2}$ cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.77
Calves 5, 6 and 7 (skim-milk alone),	0.75
Average of seven calves,	0.76

2. Price returned per quart for skim-milk, when live weight sells at 4 cents per pound: —

	Cents.
Calves 1, 2, 3 and 4 (grain and skim-milk),	0.64
Calves 5, 6 and 7 (skim-milk alone),	0.63
Average of seven calves,	0.63

Price obtained for Skim-milk per Quart when fed to Pigs.

Here follow the average results obtained from experiments with forty pigs, being six distinct lots, fed during the years 1890–91 and 1892–93. In this number grade Chester Whites predominated, but several Yorkshires, Berkshires, Poland Chinas and Tamworths are also included.

Statement.

[Cents.]

Dressed Pork sold at—	5½ Cents.	6 Cents.	6½ Cents.	7 Cents.	7½ Cents.	8 Cents.
Price returned per quart for skim-milk fed, . . .	0.21	0.30	0.46	0.58	0.70	0.81

Comments on Calf-feeding Experiment (1893).

The experiment has shown that calves grown upon skim-milk alone or upon skim-milk and grains during the first eight weeks of their lives make good gains in live weight, namely, from 0.9 to 2.13 pounds per day, with an average of 1.49 pounds. These animals, however, put on very little fat, either when fed on skim-milk alone or when fed on skim-milk and grains. They were not able to digest the necessary amount of corn meal, Buffalo gluten feed, wheat flour or middlings, when fed in connection with the nitrogenous milk, to promote the formation of fat.

The meat of the animals thus described was quite white in appearance, but not as tender as calves that were fed whole milk. The ribs and flanks of animals thus fed were thinner than those consuming whole milk, and the shrinkage in dressing was from 5 to 7 per cent. more.

Objects of the Present Experiment (1894).

I. To see if it were possible to replace the butter fat removed in the cream by some cheaper fat or oil, thus producing a mixture resembling in composition whole milk.

II. To see if this mixture would fatten calves economically.

Results of the Experiment.

I. By feeding, in addition to skim-milk, oleomargarine, cotton-seed oil, corn oil and brown sugar, calves were grown to weigh 160 pounds when seven weeks old. These calves were fairly fat, showing a better condition than calves fed on skim-milk entirely, but were not equal to sucking calves.

II. The experiment was not a financial success, however, the increased price obtained for the calves being more than counterbalanced by the cost of the fats and the extra labor in preparing the food.

III. In one case (calf 7), where oleomargarine and brown sugar were fed in addition to the skim-milk, the result was decidedly encouraging. The calf was in good condition, and returned 0.91 of a cent per quart for the skim-milk fed.

The Experiment Explained.

How the Artificial Milk was prepared.

The object was, if possible, to make an emulsion of the fat or oil with the skim-milk. For this purpose a tin vessel, very much resembling the ordinary creamery can, was made. It was twenty-two inches deep and six inches in diameter. There was a "dasher," which consisted simply of a rod about eight inches longer than the depth of the can, made of tin (or wood), to one end of which was fastened a perforated tin disk. The disk was of such a diameter that it could be worked up and down easily in the can, which was provided with a cover with a hole in the centre, through which the rod protruded. A cheap grade of oleomargarine was first used. It was added to the skim-milk and the latter heated to 110° F. This melted the "oleo," and the solution was then transferred to the tin churn and worked for several minutes. By this method the oil was quite well mixed with the milk, and the resulting solution had a very pleasant smell, closely resembling that of new milk. It was fed in a Small's calf-feeder, and the calves drank it readily. The artificial milk had practically the following composition, as compared with ordinary pure milk: —

	Artificial Milk (Per Cent.).	Pure Milk (Per Cent.).
Water,	86.60	87.00
Total solids,	13.40	13.00
Fat,	3.78	4.00

The above analysis of artificial milk represents one ounce of "oleo" to each quart of skim-milk. Scarcely any of the calves appeared to be able to take more than this amount per quart without disturbing their digestion. When one and a half ounces per quart were fed indigestion nearly always resulted, and the manure voided contained an excessive amount of fat, fatty acids and similar substances. During the last few weeks of the calf's life one and a quarter ounces were fed for each quart of the skim-milk.

Other Oils substituted.

Only one-half ounce of either cotton-seed or corn oil could be fed per quart of milk without producing bad effects. One calf was fed with one-half ounce of "oleo" and one-half ounce of cotton-seed oil per quart of milk. Another was fed with one-half ounce of "oleo" and two ounces of brown sugar per quart of skim-milk.

Following comes the financial record of the seven calves. Five were fed skim-milk and "oleo," one skim-milk and cotton-seed and corn oils, and one skim-milk, "oleo" and brown sugar.

Financial Results.

Calf 1.

Age when received: three days.

Breed: Jersey, bull.

Foods fed: whole milk for the first four days, and then gradually changing to skim-milk mixed with oleomargarine.

Financial Statement.

	Debit.	Credit.
Original cost,	$1 00	–
23.00 quarts whole milk, at 3 cents,	69	–
23.83 pounds "oleo," at $10\frac{1}{2}$ cents,	2 50	–
134.00 pounds live weight, at 5 cents,	–	$6 70
332.00 quarts skim-milk returned,	2 51	–
	$6 70	$6 70

Price returned per quart for skim-milk fed, ... 0.76 cents.

Calf 2.

Age when received: two days.
Breed: Jersey, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
45.00 quarts whole milk, at 3 cents, . . .	1 35	–
34.70 pounds "oleo," at 10½ cents, . . .	3 64	–
91.00 pounds dressed weight, at 7 cents, . .	–	$6 37
446.00 quarts skim-milk returned, . . .	38	–
	$6 37	$6 37

Price returned per quart for skim-milk fed, . . . 0.08 of a cent.

Calf 3.

Age when received: three days.
Breed: grade Durham, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
75.50 quarts whole milk, at 3 cents, . . .	2 27	–
36.33 pounds "oleo," at 10½ cents, . . .	3 81	–
86.00 pounds dressed weight, at 7½ cents, .	–	$6 45
521.00 quarts skim-milk returned, . . .	–	—0 63
	$7 08	$7 08

Calf 4.

Age when received: three days.
Breed: grade Ayrshire, heifer.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
75.50 quarts whole milk, at 3 cents, . . .	2 27	–
33.24 pounds "oleo," at $10\frac{1}{2}$ cents, . . .	3 49	–
86.50 pounds dressed weight, at $7\frac{1}{2}$ cents, .	–	$6 48
474.00 quarts skim-milk returned, . . .	–	—0 28
	$6 76	$6 76

Calf 5.

Age when received: seven days.
Breed: grade Holstein, bull.
Foods fed: whole milk first five days, and then gradually changed to skim-milk mixed with oleomargarine, cotton-seed and corn oils.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	–
50.00 quarts whole milk, at 3 cents, . . .	1 50	–
5.38 pounds "oleo," at $10\frac{1}{2}$ cents, . . .	56	–
224.00 ounces cotton-seed oil, at 8 cents, . .	1 79	–
42.00 ounces corn oil, at 8 cents, . . .	34	–
152.00 pounds live weight, at 4 cents, . .	–	$6 08
442.50 quarts skim-milk returned, . . .	89	–
	$6 08	$6 08

Price returned per quart for skim-milk fed, . . . 0.20 of a cent.

Calf 6.

Age when received: ten days.
Breed: grade Holstein, bull.
Foods fed: same as No. 1.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	-
50.00 quarts whole milk, at 3 cents, ...	1 50	-
25.81 pounds "oleo," at $10\frac{1}{2}$ cents, . . .	2 71	-
73.00 pounds dressed weight, at 8 cents, . .	-	$5 84
303.00 quarts skim-milk returned, . . .	63	-
	$5 84	$5 84

Price returned per quart for skim-milk fed, . . . 0.21 of a cent.

Calf 7.

Age when received: three days.
Breed: grade Durham, bull.
Foods fed: whole milk for first five days, then skim-milk mixed with different amounts of tallow, oleomargarine and brown sugar.

Financial Statement.

	Debit.	Credit.
Original cost, ...	$1 00	-
42.00 quarts whole milk, at 3 cents, ...	1 26	-
6.69 pounds jacket tallow, at 6 cents,* .	40	-
8.50 pounds "oleo," at $10\frac{1}{2}$ cents, . . .	89	-
8.06 pounds sugar, at 4 cents, ...	32	-
153.50 pounds live weight, at $4\frac{1}{2}$ cents, . .	-	$6 91
334.00 quarts skim-milk returned, . . .	3 04	-
	$6 91	$6 91

Price returned per quart for skim-milk fed, . . . 0.91 of a cent.

* Jacket tallow was not satisfactory; it crystallized out rapidly from the emulsion, and was consequently only partially consumed.

General Conclusions.

	1893.	1894.
Average daily gain in live weight (pounds),	1.49	1.55
Dry matter required to produce one pound live weight (pounds),	1.77	1.67
Dry matter required to produce one pound dressed weight (pounds),	2.98	3.09
Shrinkage in dressing (per cent.),	44.22	44.57
Average number of weeks fed,	10	7
Average weight of calves when sold (pounds),	177	150

The financial results of the experiment are not satisfactory. The average return for the skim-milk in case of the seven calves was but 0.28 of a cent per quart. Last year, when skim-milk alone was fed, a return of from 0.63 to 0.73 of a cent per quart was secured. Although the condition of these calves was superior to those grown on skim-milk alone, our local butcher refused to give much if any more, simply because they were not "suckers." Whole-milk veal being worth six cents, live weight, these calves were certainly worth five cents, while from nearly all of them but from four to four and a half cents could be obtained. If five cents per pound live weight had been obtained the financial showing would have been better, but even then not satisfactory. The condition of the calves fed on artificial milk was, as above mentioned, much more satisfactory than those fed on the skim-milk. They were not, however, equal in fatness to sucking calves.

Calf 1 was in a very fair condition. The kidneys were quite well covered with fat. Calves 3 and 4 were equal to No. 1. Calf 5 was fed partly on cotton-seed oil as a source of fat. When the oil was first fed the calf seemed to improve in condition, and his coat took on a glossy appearance; but continued feeding of the oil did not appear to be favorable, and when slaughtered his carcass contained very little

fat. Calf 7, fed on skim-milk with one part "oleo" to two parts brown sugar as cream substitute, gave by far the best results. He grew rapidly, making an average daily gain of 2.04 pounds, and he returned 0.91 of a cent per quart for the skim-milk fed. His kidneys were quite well covered with fat.

It is intended to note the effect of this mixture on other calves. It must be admitted that considerable labor is required to feed calves as described, and when pork brings from six and a half to seven cents per pound dressed weight it will undoubtedly be more profitable to feed the skim-milk to pigs. The average farmer would not find it profitable to attempt to fatten veal calves by this method.

If the mixture of skim-milk, "oleo" and brown sugar or skim-milk and brown sugar gives approximately as good results with the average calf as it did in case of calf 7 of the present experiment, fatting veal by this process might prove profitable to a limited number when circumstances were favorable.

When pork is below six and a half cents per pound, dressed weight, it would undoubtedly be profitable to feed the skim-milk alone to calves after they are a week old, provided they will bring four cents per pound live weight. When eight to nine weeks old they will weigh about 160 pounds.

Skim-milk can also be fed with decided profit to calves that are intended to be raised to maturity upon the farm. As soon as the animals are old enough to consume grain in addition to the milk, equal parts of Buffalo gluten feed and corn meal or cream gluten meal and corn meal can be fed dry.

Tables showing Average Daily Food Consumption and Gain in Live Weight.

Calf 1.

Weekly Periods (Dates).	Weight of Animal (Pounds).	Average Daily Amount of Feed consumed.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
May 5–7,	66.75	4.33	0.33	0.02
14,	78.50	1.43	5.43	0.36
21,	87.00	–	7.43	0.47
28,	99.00	–	9.00	0.50
June 4,	114.00	–	10.43	0.68
11,	130.25	–	11.57	0.97
13,	134.00	–	12.00	1.05
Average daily gain,	1.68	–	–	–

Calf 2.

May 5–7,	68.75	4.33	–	–
14,	74.50	3.43	1.29	0.11
21,	87.00	1.14	5.86	0.40
28,	97.50	–	8.86	0.50
June 4,	115.00	–	10.43	0.68
11,	130.25	–	11.57	0.97
18,	144.00	–	12.00	1.05
25,	157.00	–	12.00	1.05
26,	156.00	–	12.00	1.05
Average daily gain,	1.65	–	–	–

Calf 3.

Weekly Periods (Dates).	Weight of Animal (Pounds).	Average Daily Amount of Feed consumed.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
June 13,	60.50	6.00	–	–
18,	70.00	6.00	–	–
25,	79.50	2.57	3.43	0.22
July 2,	80.00	0.29	5.86	0.38
9,	92.00	–	8.14	0.53
16,	105.00	–	9.57	0.63
23,	119.50	–	10.14	0.66
30,	137.50	–	11.14	0.73
Aug. 6,	146.50	2.79	9.43	0.31
15,	153.00	–	13.00	0.99
Average daily gain,	1.45	–	–	–

Calf 4.

June 18,	75.00	4.00	–	–
25,	75.00	4.71	–	–
July 2,	82.25	3.29	2.29	0.15
9,	94.00	–	8.43	0.56
16,	105.00	–	9.57	0.63
23,	121.25	–	10.14	0.66
30,	136.50	–	11.14	0.73
Aug. 6,	142.50	2.79	9.43	0.31
13,	157.75	–	13.00	0.99
15,	156.00	–	13.00	0.99
Average daily gain,	1.37	–	–	–

Calf 5.

Weekly Periods (Dates).	Weight of Animal (Pounds).	Average Daily Amount of Feed consumed.				
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Cotton-seed Oil (Ounces).	Corn Oil (Ounces).
Aug. 14, . .	71.00	3.00	–	–	–	–
22, . .	83.50	5.13	0.75	0.05	–	–
28, . .	94.25	1.00	6.00	0.38	–	–
Sept. 4, . .	102.00	–	8.14	0.29	3.57	–
10, .	118.00	–	9.00	0.13	7.00	–
18, . .	123.50	–	9.25	–	5.63	–
24, . .	130.50	–	9.75	–	7.17	0.50
Oct. 1, . .	137.50	–	9.00	–	3.86	3.00
8, . .	148.50	–	8.57	–	3.43	2.57
11, . .	152.00	–	12.00	–	6.00	–
Av. daily gain,	1.37	–	–	–	–	–

Calf 6.

Weekly Periods (Dates).	Weight of Animal (Pounds).	Average Daily Amount of Feed consumed.		
		Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).
Aug. 14, ...	87.00	3.00	–	–
22, ...	98.50	5.13	0.75	0.05
28, ...	109.00	1.00	6.00	0.38
Sept. 4, ...	115.00	–	8.14	0.73
10, ...	122.50	–	9.00	0.84
17, ...	131.50	–	9.57	0.90
24, ...	138.50	–	9.86	0.88
26, ...	144.00	–	11.00	0.69
Average daily gain, .	1.30	–	–	–

Calf 7.

WEEKLY PERIODS (DATES).	Weight of Animal (Pounds).	AVERAGE DAILY AMOUNT OF FEED CONSUMED.				
		Whole Milk (Quarts).	Skim-milk (Quarts).	Jacket Tallow (Pounds).	"Oleo" (Pounds).	Sugar (Pounds).
Sept. 4, . .	70.00	–	–	–	–	–
10, . .	77.00	5.00	–	–	–	–
17, . .	87.00	1.71	4.57	0.29	–	–
24, . .	98.00	–	8.14	0.51	–	–
Oct. 1, . .	118.00	–	9.86	0.16	0.41	0.05
8, . .	137.50	–	11.14	–	0.38	0.47
15, . .	153.50	–	12.14	–	0.38	0.59
Av. daily gain,	2.04	–	–	–	–	–

TABLES GIVING DETAILED RECORD OF EACH CALF.

Calf 1.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	May 5 to May 28,	23.00	154.00	10.00	1 : 4	66.75	99.00	1.34	7.53
II.	May 29 to June 13,	-	178.00	13.83	1 : 4.4	99.00	134.00	2.20	6.43

Total Amount of Feed consumed from May 5 to June 13, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
23.00 quarts whole milk, ...	6.83	$0 69	$0 04
332.00 quarts skim-milk, ...	69.34	1 49	49
23.83 pounds "oleo,"	23.83	2 50	-
	100.00	$4 68	$0 53

Live weight of the animal at the beginning of the experiment, 66.75 lbs.
Live weight of the animal at the end of the experiment, . 134.00 "
Live weight gained during the experiment, ... 67.25 "
Dressed weight of the animal, ... 74.00 "
Loss in weight by dressing, 44.78 per cent., . . . 60.00 "
Pounds of dry matter to produce 1 pound of live weight, . 1.29 "
Pounds of dry matter to produce 1 pound of dressed weight, 2.69 "
Total cost of feed per pound of live weight gained, . . 6.95 cts.
Net cost of feed per pound of live weight gained, . . 6.17 "

Calf 2.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	May 5 to May 28,	45.00	112.00	7.50	1:4.25	68.75	97.50	1.20	9.19
II.	May 29 to June 11,	-	154.00	11.60	1:4.2	97.50	130.25	2.34	5.84
III.	June 12 to June 26,	-	180.00	15.60	1:4.6	130.25	156.00	1.72	9.51

Total Amount of Feed consumed from May 5 to June 26, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
45.00 quarts whole milk, ...	13.37	$1 35	$0 07
446.00 quarts skim-milk, ...	93.14	2 01	66
34.70 pounds "oleo,"	34.70	3 64	–
	141.21	$7 00	$0 73

Live weight of the animal at the beginning of the experiment,	68.75 lbs.
Live weight of the animal at the end of the experiment, .	156.00 "
Live weight gained during the experiment, ...	87.25 "
Dressed weight of the animal, ...	91.00 "
Loss in weight by dressing, 41.67 per cent., ...	65.00 "
Pounds of dry matter to produce 1 pound of live weight, .	1.62 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.77 "
Total cost of feed per pound of live weight gained, . .	8.02 cts.
Net cost of feed per pound of live weight gained, . .	7.19 "

Calf 3.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	June 13 to July 9,	56.00	122.00	8.01	1:4.2	60.50	92.00	1.17	9.75
II.	July 10 to July 23,	–	138.00	9.06	1:4.1	92.00	119.50	1.96	5.72
III.	July 24 to Aug. 15,	19.50	261.00	19.26	1:4.3	119.50	153.00	1.46	11.29

Total Amount of Feed consumed from June 13 to Aug. 15, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
75.50 quarts whole milk,	22.43	$2 27	$0 12
521.00 quarts skim-milk,	109.77	2 34	77
36.33 pounds "oleo,"	36.33	3 81	–
	168.53	$8 42	$0 89

Live weight of the animal at the beginning of the experiment,	60.50 lbs.
Live weight of the animal at the end of the experiment,	153.00 "
Live weight gained during the experiment,	92.50 "
Dressed weight of the animal,	86.00 "
Loss in weight by dressing, 43.79 per cent.,	67.00 "
Pounds of dry matter to produce 1 pound of live weight,	1.82 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.24 "
Total cost of feed per pound of live weight gained,	9.10 cts.
Net cost of feed per pound of live weight gained,	8.14 "

Calf 4.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	June 18 to July 16,	56.00	142.00	9.32	1:4.2	75.00	105.00	1.03	10.99
II.	July 17 to July 30,	-	149.00	9.78	1:4.1	105.00	136.50	2.25	5.39
III.	July 31 to Aug. 15,	19.50	183.00	14.14	1:4.4	136.50	156.00	1.22	14.82

Total Amount of Feed consumed from June 18 to Aug. 15, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
75.50 quarts whole milk, ...	22.43	$2 27	$0 12
474.00 quarts skim-milk, ...	98.99	2 13	70
33.24 pounds "oleo,"	33.24	3 49	–
	154.66	$7 89	$0 82

Live weight of the animal at the beginning of the experiment,	75.00 lbs.
Live weight of the animal at the end of the experiment, .	156.00 "
Live weight gained during the experiment, ...	81.00 "
Dressed weight of the animal, ...	86.50 "
Loss in weight by dressing, 44.55 per cent., ...	69.50 "
Pounds of dry matter to produce 1 pound of live weight, .	1.91 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.44 "
Total cost of feed per pound of live weight gained, . .	9.74 cts.
Net cost of feed per pound of live weight gained, . .	8.73 "

Calf 5.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	"Oleo" (Pounds).	Cotton-seed Oil (Pounds).	Corn Oil Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Aug. 14 to Sept. 4,	50.00	99.00	4.63	1.56	–	1:4	71.00	102.00	1.41	8.49
II.	Sept. 5 to Sept. 18,	–	128.00	0.75	5.44	–		102.00	123.50	1.54	6.28
III.	Sept. 19 to Oct. 11,	–	215.50	–	7.00	2.62		123.50	152.00	1.24	7.72

Total Amount of Feed consumed from Aug. 14 to Oct. 11, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
50.00 quarts whole milk, ...	14.86	$1 50	$0 08
442.50 quarts skim-milk, ...	92.41	1 99	65
5.38 pounds "oleo,"	5.38	56	–
224.00 ounces cotton-seed oil, ...	14.00	1 79	–
42.00 ounces corn oil, ...	2.63	34	–
	129.28	$6 18	$0 73

Live weight of the animal at the beginning of the experiment,	71.00 lbs.
Live weight of the animal at the end of the experiment, .	152.00 "
Live weight gained during the experiment, ...	81.00 "
Dressed weight of the animal, ...	–
Loss in weight by dressing, per cent., ...	–
Pounds of dry matter to produce 1 pound of live weight, .	1.60 "
Pounds of dry matter to produce 1 pound of dressed weight,	–
Total cost of feed per pound of live weight gained, . . .	7.63 cts.
Net cost of feed per pound of live weight gained, . . .	6.73 "

Calf 6.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Cotton-seed Oil (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Aug. 14 to Aug. 22,	44.00	6.00	0.37	1:4 to 1:4.5	87.00	98.50	1.28	12.04
II.	Aug. 23 to Sept. 10,	6.00	147.00	12.41		98.50	122.50	1.26	8.93
III.	Sept. 11 to Sept. 26,	-	150.00	13.03		122.50	144.00	1.34	9.50

Total Amount of Feed consumed from Aug. 14 to Sept. 26, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
50.00 quarts whole milk, ...	14.86	$1 50	$0 08
303.00 quarts skim-milk, ...	63.28	1 36	45
25.81 pounds "oleo,"	25.81	2 71	-
	103.95	$5 57	$0 53

Live weight of the animal at the beginning of the experiment,	87.00 lbs.
Live weight of the animal at the end of the experiment, .	144.00 "
Live weight gained during the experiment, ...	57.00 "
Dressed weight of the animal, ...	73.00 "
Loss in weight by dressing, 49.31 per cent., . .	71.00 "
Pounds of dry matter to produce 1 pound of live weight,	1.82 "
Pounds of dry matter to produce 1 pound of dressed weight,	3.51 "
Total cost of feed per pound of live weight gained, . .	9.77 cts.
Net cost of feed per pound of live weight gained, . .	8.84 "

Calf 7.

Feeding Periods.	Date of Periods.	Whole Milk (Quarts).	Skim-milk (Quarts).	Jacket Tallow (Pounds).	"Oleo" (Pounds).	Sugar (Pounds).	Approximate Nutritive Ratio.	Weight of Animal at Beginning of Period (Pounds).	Weight of Animal at End of Period (Pounds).	Average Daily Gain (Pounds).	Cost of Feed per Pound of Live Weight gained (Cents).
I.	Sept. 4 to Sept. 24,	42.00	89.00	5.56	–	–	1:3.5 to 1:4	70.00	98.00	1.33	7.12
II.	Sept. 25 to Oct. 1,	–	69.00	1.13	2.88	0.37		98.00	118.00	2.86	3.48
III.	Oct. 2 to Oct. 16,	–	176.00	–	5.62	7.69		118.00	153.50	2.33	4.70

Total Amount of Feed consumed from Sept. 4 to Oct. 16, 1894.

	Dry Matter (Pounds).	Total Cost.	Manurial Value Obtainable.
42.00 quarts whole milk,	12.47	$1 26	$0 06
334.00 quarts skim-milk,	69.75	1 50	49
6.69 pounds jacket tallow,	6.69	40	–
8.50 pounds "oleo,"	8.50	89	–
8.06 pounds sugar,	8.06	32	–
	105.47	$4 37	$0 53

Live weight of the animal at the beginning of the experiment,	70.00 lbs.
Live weight of the animal at the end of the experiment,	153.50 "
Live weight gained during the experiment,	63.50 "
Dressed weight of the animal,	87.00 "
Loss in weight by dressing, 43.32 per cent.,	66.50 "
Pounds of dry matter to produce 1 pound of live weight,	1.66 "
Pounds of dry matter to produce 1 pound of dressed weight,	2.93 "
Total cost of feed per pound of live weight gained,	6.88 cts.
Net cost of feed per pound of live weight gained,	6.05 "

Average Analyses of Milks.

Fodder Analyses	Skim-milk.	Whole Milk.
Moisture at 100° C.,	90.42	86.18
Dry matter,	9.58	13.82
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.14	5.35
" cellulose,	–	–
" fat,	2.61	33.43
" protein,	35.23	25.33
Non-nitrogenous extract matter,	54.02	35.89
	100.00	100.00

Fertilizing Constituents.

[Nitrogen 15 cents, phosphoric acid 5 cents, potassium oxide 5 cents, per pound]

Fertilizer Analyses.	Skim-milk.	Whole Milk.
Moisture,	90.42	86.18
Nitrogen,	0.52	0.56
Phosphoric acid,	0.18	0.19
Potassium oxide,	0.19	0.17
Value per 2,000 pounds,	$1 93	$2 04
Manurial value obtainable,*	1 35	1 43

* Allowing thirty per cent. of the fertilizing constituents to be retained in the system of the growing animal.

Local Market Value of the Various Foods.

Whole milk (per gallon),	12.0 cts.
Skim-milk (per gallon),	1.8 "
Cotton-seed oil (per gallon),	$1 00
Corn oil (per gallon),	1 00
Oleomargarine (per pound),	10.5 cts.
Jacket tallow (per pound),	5.5 "
Brown sugar (per pound),	4.0 "

VIII.

DIGESTION EXPERIMENTS.

1. DIGESTION EXPERIMENTS WITH SHEEP.

BY J. B. LINDSEY, R. H. SMITH AND E. B. HOLLAND.

During the past year we have continued the study of the digestibility of the concentrated by-products so freely offered for sale in our eastern markets. Especial attention has been given to the gluten feeds and meals. The results obtained with the gluten feeds are not as yet decisive. The coefficients of digestibility, in case of different samples of these feeds, appear to vary considerably. Whether this is caused by the method of preparation is not as yet clear. Additional tests will be made.

VALUE OF DIGESTION EXPERIMENTS.

1. A food is valuable as a source of nourishment only in so far as its various constituents can be digested and assimilated. Two kinds of hay, one early and the other late cut, might be consumed in equal quantities by an animal, yet the early cut hay, having more digestible matter, would prove the more valuable fodder.

For one to form an intelligent opinion as to the value of different fodder stuffs, the amount of digestible matter they contain must be known.

2. In order to combine the different fodder stuffs so as to obtain properly balanced rations for our farm stock, one should know the percentages of the different digestible constituents contained in each of the several foods.

The Excreta of an Animal, — what they are.

The fæces are nothing more than the undigested portions of the food. They are the portions that have resisted the action of the various secretions of the stomach and digestive fluids and bacteria of the intestines, and are consequently excreted by the animal as so much worthless material. The urine is entirely distinct from the fæces. It contains the water and the end products of the digestion of the nitrogenous portion of the food, — the urea and hippuric acid, — which have been removed from the blood by the kidneys. It also contains about one-third of the phosphoric acid and nearly all of the alkalies of the food consumed that have not been retained in the animal's system, and small quantities of other materials that it is unnecessary to consider in this connection.

How the Digestible Matter of a Food is determined.

First ascertain the amount and composition of the food consumed by an animal in a given length of time, also the amount and composition of the fæces or undigested portion excreted in the same time on the basis of dry matter. The difference between them will represent the amount of the various constituents of the food digested.

The percentages of the constituents digested are called the digestion coefficients.

A Single Illustration, showing how the Digestibility of a Fodder is determined.

[Solid manure equals the undigested part of food.]

English Hay.

	Dry Matter (Grams).	Crude Cellulose (Grams).	Crude Fat (Grams).	Crude Protein (Grams).	Extract Matter (Grams).
900 grams hay fed, equal to . . .	765.36	250.58	23.57	82.58	348.69
369.3 grams manure excreted, equal to	337.95	107.00	12.81	34.64	145.89
Amount of hay digested, . .	427.41	143.58	10.76	47.94	202.80
Per cent. digested, ...	55.84	57.30	45.65	58.05	58.16

Methods Employed.

Four sheep were used. Nos. 1 and 2 were four years old, and Nos. 3 and 4 two years. The full details of the method will be found fully described in the eleventh report of this station, 1893.

Feeds Tested.

Hay of Mixed Grasses.

The hay is a fair average of that grown upon the station grounds. It was harvested the latter part of June, when the various grasses were in blossom. The grasses of which it was composed were principally herds grass, red top, Kentucky blue grass, meadow fescue, sweet-scented vernal grass, together with a fair sprinkling of clover. It was fed alone, and as a coarse fodder in combination with the different grains tested.

Vetch and Oats.

The vetch and oats are fed by us as a substitute for hay. They were sown at the rate of 4 bushels of oats and 40 pounds of vetch per acre about the middle of April. These were cut in late blossom, and made into hay. If cut in early bloom they would probably prove somewhat more digestible.

New-process Linseed Meal.

Linseed meal is the flaxseed remaining after the oil has been removed. In case of the new-process meal the oil is extracted by naphtha or some similar solvent, and is in consequence more thoroughly removed than by pressure.

Buffalo Gluten Feed.

This is a by-product in the manufacture of starch from corn. The starch is separated from the yellow or albuminous part of the grain by means of water. The hulls and germs are separated by screening. After the starch is removed the yellow or flinty portion is mixed with the germs and hulls. The mixture is kiln-dried and partially ground.

Peoria Gluten Feed.

Similar in appearance to the Buffalo, but the sample tested was rather inferior in composition. It is probably prepared from corn, in much the same way as the Buffalo gluten feed.

Chicago Maize Feed.

This feed is also prepared from corn. It is said to be a mixture of the yellow albuminous portion and the hulls without the germ. It contains, therefore, somewhat less fat than the gluten feeds. The hulls are not ground quite as fine.

Chicago Gluten Meal.

This is the yellow albuminous portion of the corn kernel. It contains much less fat than the other gluten meals. It was in good mechanical condition, and quite dry.

King Gluten Meal.

This meal was ground very fine. It contained a very high percentage of fat (19 per cent.).

Atlas Meal.

This is a by-product obtained from corn or grain in the process of the manufacture of alcohol. The starch of the grain is converted into sugar by the action of diastase, and finally into alcohol by fermentation. The hull, gluten and germ are left behind. The meal is probably composed of these, together with an admixture of malt sprouts. It is rich in fat and albuminoids. It is made by the Atlas Distilling Company, Peoria, Ill.

Peanut Feed.

This material appears to be peanut shells finely ground, with a small admixture of the nut. It contained over 50 per cent. of cellulose.

Soja-bean Meal.

The beans were raised upon the grounds of the Hatch Experiment Station. The quantity necessary for the experiment was supplied through the kindness of Professor Brooks.

Rye Meal.

The rye was raised upon the station grounds, and was of good average quality.

Winter Wheat Bran.

A fair sample of genuine winter bran.

Results of the Experiment.

Digestibility of the Foods.

	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of mixed grasses (*a*),	1	4	59	62	50	58	59
Hay of mixed grasses (*d*),	1	3	55	57	47	58	57
Average of both samples,	2	7	57	60	49	58	58
Vetch and oats,	1	2	58	66	19	60	54
New-process linseed meal,	1	2	77	99	102?	83	87
Buffalo gluten feed,	1	2	90	100	94	89	89
Peoria gluten feed,	1	2	86	78	79	83	90
Chicago maize feed,	1	2	87	82	92	85	88
Chicago gluten meal,	1	2	93	22	97	91	97
King gluten meal,	1	2	85	–	95	92	84
Atlas meal,	1	2	80	106?	91	73	84
Peanut feed,	1	2	32	12	90	71	49
Soja-bean meal,	1	2	82	71	86	91	76
Rye meal,	1	2	87	–	64	84	92
Winter wheat bran,	1	2	62	14	67	78	72

Comments on the Results.

Hays.

The hays prove to be about as digestible as those tested a year ago, and correspond in digestibility very closely to the figures given by Wolff.

Vetch and Oats.

The vetch and oats hay appears, with the exception of the fat, to be about as digestible as good English hay.

New-process Linseed Meal.

This test corresponds fairly with those made a year ago. The animal appeared to have very thoroughly assimilated the fat of the meal.

Buffalo Gluten Feed.

This sample gives distinctly higher digestion percentages than the one tested a year ago. The reason for this cannot be given. The parallel tests in each case agree closely. Other samples will be procured and further tests made.

Peoria Gluten and Chicago Maize Feeds.

These two gluten feeds correspond very closely one with the other in the amounts of digestible matter they contain. The Peoria feed was inferior in composition to the maize feed.

Chicago Gluten Meal.

As there is comparatively no cellulose in this and the King gluten meal, that ingredient is not to be considered. The Chicago meal shows an exceptional degree of digestibility, 93 per cent. of the entire meal having been assimilated.

King Gluten Meal.

The King gluten meal was also quite digestible, 85 per cent. of the total dry matter being assimilated.

Atlas Meal.

This meal has 80 per cent. of digestible matter. The protein is about 73 per cent. digestible. It is somewhat inferior to the gluten meals in digestibility, although, with the exception of the increased percentage of cellulose present, it resembles them in composition. The cellulose appears in this test to have been all digested. This meal is a valuable addition to our feed-stuff supply, if it can be bought at a reasonable price. Additional digestion tests will be made.

Peanut Feed.

This material is unquestionably of inferior feeding value. Its dry matter was but 32 per cent. digestible, and it contained 54 per cent. of cellulose, of which but 12 per cent. were digested. The fat and protein were quite well assimilated, but the percentages contained — especially that of the protein — were comparatively small. The extract matter was only 49 per cent. digestible.

Soja-bean Meal.

The test of this meal was not entirely satisfactory, the variations in the percentages of cellulose and fat digestible in case of the two sheep being too large. Wolff gives the results of but two single trials with this meal, which correspond fairly with the figures found in our trial.

Rye Meal.

Wolff gives no direct digestion coefficients for rye. Our results make it appear practically as digestible as the corn meal, the protein even more so.

Winter Wheat Bran.

The digestibility of this bran is practically the same as the spring bran reported last year. As these two brans appear to have also the same percentage composition, they should be worth the same price per ton. Different seasons might exert some influence on composition and digestibility.

Details of the Experiment.

Dry Matter Determinations made at the Time of Weighing out the Different Foods, and Dry Matter in Manure excreted.

Sheep I.

Periods.	Hay.	New-process Linseed Meal.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Rye Meal.	Winter Wheat Bran.	Waste.	Manure.
I.,	88.48	-	-	-	-	-	-	84.30	90.26
II.,	87.81	-	-	-	-	-	-	-	91.14
IV.,	85.99	89.39	-	-	-	-	-	-	92.98
VI.,	88.40	-	90.08	-	-	-	-	-	91.84
VIII.,	86.28	-	-	-	90.31	-	-	-	93.27
IX.,	86.49	-	-	91.62	-	-	-	-	91.77
XIII.,	87.19	-	-	-	-	85.74	-	-	94.95
XIV.,	86.31	-	-	-	-	-	86.29	-	93.25

Sheep II.

Periods.	Hay.	New-process Linseed Meal.	Peoria Gluten Feed.	King Gluten Meal.	Chicago Gluten Meal.	Rye Meal.	Winter Wheat Bran.	Waste.	Manure.
I.,	88.48	-	-	-	-	-	-	-	89.58
II.,	87.81	-	-	-	-	-	-	-	91.33
VIII.,	86.28	-	-	-	90.31	-	-	-	93.14
IX.,	86.49	-	-	91.62	-	-	-	-	91.17
XIII.,	87.19	-	-	-	-	85.74	-	-	95.14
XIV.,	86.31	-	-	-	-	-	86.29	-	93.14

Sheep III.

Periods.	Hay.	Vetch and Oats.	Buffalo Gluten Feed.	Chicago Maize Feed.	Peoria Gluten Feed.	Atlas Meal.	Peanut Feed.	Soja-bean Meal.	Waste.	Manure.
I.,	88.48	-	-	-	-	-	-	-	85.40	91.00
II.,	88.40	-	-	-	-	-	-	-	-	91.91
III.,	-	85.12	-	-	-	-	-	-	-	91.71
V.,	86.28	-	91.86	-	-	-	-	-	-	93.48
VII.,	86.49	-	-	89.72	-	-	-	-	-	91.34
X.,	84.66	-	-	-	-	91.04	-	-	-	94.56
XI.,	87.85	-	-	-	-	-	90.43	-	-	94.31
XII.,	86.31	-	-	-	-	-	-	90.22	-	93.20

SHEEP IV.

PERIODS.	Hay.	Vetch and Oats.	Buffalo Gluten Feed.	Chicago Maize Feed.	Peoria Gluten Feed.	Atlas Meal.	Peanut Feed.	Soja-bean Meal.	Waste.	Manure.
I., ...	88.48	-	-	-	-	-	-	-	-	93.08
II., ...	88.40	-	-	-	-	-	-	-	-	92.04
III., ...	-	85.12	-	-	-	-	-	-	-	90.73
V., ...	86.28	-	91.86	-	-	-	-	-	-	93.20
VI., ...	87.19	-	-	-	89.72	-	-	-	-	94.88
VII., . .	86.49	-	-	89.72	-	-	-	-	-	91.49
X., ...	84.66	-	-	-	-	91.04	-	-	-	94.46
XI., ...	87.85	-	-	-	-	-	90.43	-	-	94.14
XII., ...	86.31	-	-	-	-	-	-	90.22	-	93.20

Composition of Feed Stuffs.

[Dry Matter.]

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay (*a*), ...	7.09	32.09	3.23	11.17	46.42
Hay (*b*), ...	7.99	32.50	2.29	9.74	47.48
Hay (*c*), ...	7.28	33.43	2.54	9.74	47.01
Hay (*d*) (average *b* and *c*), ...	7.63	32.96	2.41	9.74	47.24
Vetch and oats, ...	10.65	35.95	2.61	13.42	37.37
Winter wheat bran, ...	7.59	10.64	4.97	15.61	61.19
Soja-bean meal, ...	6.20	4.50	18.89	38.47	31.94
New-process linseed meal, ...	6.02	8.04	4.30	41.38	40.26
Chicago maize feed, ...	0.80	9.06	9.00	26.13	55.01
Buffalo gluten feed, ...	0.40	8.46	13.32	22.93	54.89
Peoria gluten feed, ...	0.84	8.30	6.27	19.24	65.35
Chicago gluten meal, ...	0.14	1.73	4.60	37.09	56.44
King gluten meal, ...	1.50	1.41	19.68	38.57	38.84
Peanut feed, ...	5.06	54.40	5.54	12.06	22.94
Rye meal, ...	1.16	1.79	1.79	13.63	81.63
Atlas meal, ...	1.03	9.73	42.63	15.77	30.84
Waste, Sheep I., ...	10.91	30.88	3.42	12.21	42.58
Waste, Sheep III., ...	9.95	32.16	3.10	11.37	43.42

Composition of Fæces.

[Dry Matter.]

SHEEP I.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.01	29.92	3.89	11.21	45.97
Period XIV.					
Hay (*a*) and winter wheat bran, .	11.41	28.19	4.61	10.57	45.22
Period VIII.					
Hay (*a*) and Chicago gluten meal, .	9.01	28.41	3.86	13.84	44.88
Period IX.					
Hay (*a*) and King gluten meal, .	9.50	27.28	4.73	12.68	45.81
Period IV.					
Hay (*a*) and new-process linseed meal, ...	10.00	29.78	3.26	14.50	42.46
Period II.					
Hay (*b*), ...	11.40	31.34	2.65	9.06	45.55
Period VI.					
Hay (*d*) and Peoria gluten feed, .	10.75	29.88	3.47	10.94	44.96
Period XIII.					
Hay (*d*) and rye meal, ...	11.08	30.05	3.20	10.44	45.23

SHEEP II.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	8.37	29.96	3.75	11.54	46.38
Period XIV.					
Hay (*a*) and winter wheat bran, .	11.78	27.33	3.58	10.73	46.58
Period VIII.					
Hay (*a*) and Chicago gluten meal, .	8.86	29.28	3.84	12.94	45.08
Period IX.					
Hay (*a*) and King gluten meal, .	9.06	29.21	3.87	12.19	45.67
Period II.					
Hay (*b*), ...	11.92	30.40	2.57	10.18	44.93
Period XIII.					
Hay (*d*) and rye meal, ...	10.24	29.49	3.10	9.72	47.45

Sheep III.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.)	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.30	28.94	4.35	11.75	45.66
Period XII.					
Hay (*a*) and soja-bean meal, . .	11.21	25.89	6.26	12.54	44.10
Period V.					
Hay (*a*) and Buffalo gluten feed, .	8.76	26.81	4.50	12.72	47.21
Period VII.					
Hay (*a*) and Chicago maize feed, .	8.26	27.29	4.29	13.81	46.35
Period III.					
Vetch and oats, ...	11.81	29.88	5.18	12.51	40.62
Period II.					
Hay (*c*), ...	10.67	31.53	3.07	9.18	45.55
Period XI.					
Hay (*d*) and peanut feed, . .	9.70	49.96	1.92	7.25	31.17
Period X.					
Hay (*d*) and atlas meal, . . .	11.39	27.49	3.24	15.21	42.67

Sheep IV.

	Crude Ash (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.)	Extract Matter (Per Cent.).
Period I.					
Hay (*a*), ...	9.23	28.96	3.89	10.90	47.02
Period XII.					
Hay (*a*) and soja-bean meal, . .	9.77	25.76	5.17	12.61	46.69
Period V.					
Hay (*a*) and Buffalo gluten feed, .	8.85	26.47	4.20	12.89	47.59
Period VII.					
Hay (*a*) and Chicago maize feed, .	7.87	27.48	4.13	13.31	47.21
Period III.					
Vetch and oats, ...	12.12	28.43	4.96	13.31	41.18
Period II.					
Hay (*c*), ...	11.93	31.26	2.99	8.94	44.88
Period XI.					
Hay (*d*) and peanut feed, . .	8.07	48.75	1.95	7.37	33.86
Period VI.					
Hay (*d*) and Peoria gluten feed, .	11.45	28.04	3.84	10.60	46.07
Period X.					
Hay (*d*) and atlas meal, . . .	12.32	26.21	3.49	15.38	42.60

Tables showing Food fed and Water drank Daily, the Daily Amount of Manure excreted and the Temperature of the Stables.

PERIOD I.

[Food consumed daily: 900 grams hay (*a*) and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.*	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
March 29,	37.0	874	34.06	2,035	926	33.30	2,002
30,	44.0	865	37.78	2,068	1,010	48.08	1,780
31,	35.5	805	31.30	2,055	989	37.86	1,542
April 1,	54.5	833	34.06	2,128	1,040	36.76	1,860
2,	46.0	819	30.58	2,202	903	34.60	1,490
3,	37.5	908	39.99	2,167	834	34.55	1,570
4,	41.5	808	32.13	2,047	812	32.93	1,610
Averages,	42.3	845	34.27	2,100	931	36.87	1,693

* One-tenth preserved as daily sample in all cases except Period IV.

Weight of Sheep I. at beginning of period, ... 115.00 lbs.
Weight of Sheep II. at beginning of period, ... 117.00 "
Weight of Sheep I. at end of period, ... 114.50 "
Weight of Sheep II. at end of period, ... 117.50 "

[Food consumed daily: 900 grams hay (*a*) and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
March 29,	37.0	823	31.55	1,935	687	33.71	1,415
30,	44.0	890	37.04	2,258	621	31.44	1,694
31,	35.5	909	33.00	1,682	690	33.07	1,263
April 1,	54.5	1,158	39.31	1,319	739	35.37	1,609
2,	46.0	897	31.97	1,428	709	34.47	1,990
3,	37.5	791	32.75	1,670	642	29.83	1,159
4,	41.5	733	30.45	1,943	680	32.35	1,690
Averages,	42.3	886	33.72	1,748	681	32.89	1,546

Weight of Sheep III. at beginning of period, ... 115.25 lbs.
Weight of Sheep IV. at beginning of period, ... 115.75 "
Weight of Sheep III. at end of period, ... 118.50 "
Weight of Sheep IV. at end of period, ... 117.25 "

Period II.

[Food consumed daily: 900 grams hay (*b*) and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
September 27, .	58.0	900	36.93	1,685	1,176	41.69	1,693
28, .	64.0	933	40.81	1,861	1,182	40.84	1,749
29, .	69.5	914	39.00	1,838	1,037	36.10	1,531
30, .	62.0	998	43.41	2,208	-	-	-
October 1, .	-	903	37.28	1,353	-	-	-
2, .	59.5	982	41.55	2,078	-	-	-
3, .	-	1,003	40.85	1,645	-	-	-
Averages, .	62.6	948	39.98	1,810	1,132	39.54	1,658

Weight of Sheep I. at beginning of period, ... 116.50 lbs.
Weight of Sheep II. at beginning of period, ... 114.00 "
Weight of Sheep I. at end of period, ... 116.50 "
Weight of Sheep II. at end of period, ... –* "

* Not determined.

[Food consumed daily: 900 grams hay (*c*) and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 7, .	58.0	804	39.75	1,090	998	39.86	1,685
8, .	57.0	814	39.39	950	1,134	39.16	1,548
9, .	62.5	753	37.48	1,325	1,003	38.88	1,402
10, .	52.5	806	40.56	1,193	909	37.26	2,202
11, .	55.0	880	41.37	1,175	1,081	37.82	468
12, .	57.5	740	36.15	1,063	813	36.57	1,951
13, .	51.0	812	39.73	1,200	778	35.53	1,787
Averages, .	56.2	801	39.20	1,142	959	37.87	1,577

Weight of Sheep III. at beginning of period, ... 118.75 lbs.
Weight of Sheep IV. at beginning of period, ... 116.50 "
Weight of Sheep III. at end of period, ... 118.00 "
Weight of Sheep IV. at end of period, ... 116.50 "

Period III.

[Food consumed daily: 900 grams vetch and oats and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
September 23, .	64.0	842	30.84	2,115	1,003	33.58	2,325
24, .	64.0	903	34.65	2,435	1,086	39.97	2,500
25, .	61.0	1,262	41.04	2,500	966	34.04	2,500
26, .	57.0	1,311	35.93	2,500	1,018	35.30	2,500
27, .	58.0	1,061	36.36	3,160	1,049	34.48	3,483
28, .	64.0	1,046	37.52	2,062	1,018	34.32	2,063
29, .	62.0	1,029	38.83	1,538	1,017	35.69	2,321
Averages, .	61.4	1,065	37.88	2,330	1,022	35.34	2,527

Weight of Sheep III. at beginning of period, ... 119.50 lbs.
Weight of Sheep IV. at beginning of period, ... 118.50 "
Weight of Sheep III. at end of period, ... 119.00 "
Weight of Sheep IV. at end of period, ... 117.00 "

Period IV.

[Food consumed daily: 600 grams hay (*a*), 200 grams new-process linseed meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.		
		Manure excreted Daily.*	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.
May 31, ...	56.5	567	58.80	2,358
June 1, ...	62.0	536	49.43	2,500
2, ...	57.5	680	62.82	1,700
3, ...	64.0	562	49.30	1,388
4, ...	70.0	583	52.35	2,450
5, ...	59.5	679	56.59	2,455
6, ...	56.0	558	50.12	1,935
Averages, ...	60.8	595	54.20	2,112

* One-fifth of total amount excreted preserved as daily sample; in all other periods one-tenth preserved.

Weight of animal at beginning of period, ... 117.00 lbs.
Weight of animal at end of period, ... 115.75 "

PERIOD V.

[Food consumed daily: 600 grams hay (*a*), 250 grams Buffalo gluten feed and 5 grams salt.]

DATE.	Stable Temperature (Fahr.).	SHEEP III.			SHEEP IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 2, . .	76.5	544	24.67	2,077	572	25.82	2,013
3, . .	70.0	519	24.28	1,865	521	23.05	2,337
4, . .	61.5	588	25.29	1,928	471	22.36	2,093
5, . .	55.0	647	28.06	1,588	598	27.84	1,865
6, . .	70.0	624	27.08	1,829	511	24.44	2,078
7, . .	71.5	535	23.67	1,938	511	23.99	1,372
8, . .	–	600	24.13	1,961	565	27.11	1,754
Averages, .	67.4	580	25.31	1,884	536	24.94	1,930

Weight of Sheep III. at beginning of period, ... 115.75 lbs.
Weight of Sheep IV. at beginning of period, ... 116.50 "
Weight of Sheep III. at end of period, ... 115.00 "
Weight of Sheep IV. at end of period, ... 115.50 "

PERIOD VI.

[Food consumed daily by Sheep I.: 550 grams hay (*d*), 250 grams Peoria gluten feed and 5 grams salt; food consumed daily by Sheep IV.: 600 grams hay (*d*), 250 grams Peoria gluten feed and 5 grams salt.]

DATE.	SHEEP I.				SHEEP IV.*			
	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Stable Temperature (Fahr.).	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Degrees.	Grams.	Grams.	Grams.
October 12, .	56.5	534	22.10	1,638	–	–	–	–
13, .	51.0	641	26.51	1,080	36.5	569	26.61	943
14, .	54.0	649	25.73	1,105	41.5	600	28.00	632
15, .	48.5	768	33.69	2,100	48.0	628	28.59	647
16, .	48.0	730	30.05	1,840	44.0	497	24.23	1,181
17, .	55.5	694	28.07	892	39.0	607	25.81	1,625
18, .	51.0	655	28.18	1,687	39.0	844	33.10	825
19, .	–	–	–	–	–	850	28.79	1,133
Averages,	52.1	667	27.76	1,477	41.3	656	27.88	998

* The period for Sheep IV. occupied the dates November 13-19 inclusive.

Weight of Sheep I. at beginning of period, ... 111.75 lbs.
Weight of Sheep IV. at beginning of period, ... 113.50 "
Weight of Sheep I. at end of period, ... 113.50 "
Weight of Sheep IV. at end of period, ... 113.25 "

PERIOD VII.

[Food consumed daily: 600 grams hay (*a*), 250 grams Chicago maize feed and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 15, . .	60.5	594	27.00	2,137	611	28.73	2,325
16, . .	58.0	573	26.21	2,114	507	23.24	2,441
17, . .	64.0	537	23.92	1,730	567	28.00	2,013
18, . .	65.0	613	28.46	1,770	523	25.93	1,330
19, . .	64.5	528	24.93	1,640	518	23.68	2,319
20, . .	63.0	351	15.76	1,784	586	27.31	1,507
21, . .	57.0	1,054	37.09	1,255	620	29.44	1,125
Averages, .	61.7	607	26.20	1,776	562	26.62	1,866

Weight of Sheep III. at beginning of period, ... 117.00 lbs.
Weight of Sheep IV. at beginning of period, ... 117.00 "
Weight of Sheep III. at end of period, ... 119.50 "
Weight of Sheep IV. at end of period, ... 120.00 "

PERIOD VIII.

[Food consumed daily: 650 grams hay (*a*), 200 grams Chicago gluten meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 1, . .	70.0	534	24.12	2,253	794	23.08	2,109
2, . .	76.5	642	26.72	2,457	820	26.74	2,426
3, . .	70.0	636	25.65	3,423	821	26.60	2,105
4, . .	61.5	658	26.51	2,160	727	25.37	1,864
5, . .	55.0	669	26.97	1,963	822	28.83	1,774
6, . .	70.0	777	29.15	2,352	684	24.39	1,915
7, . .	71.5	714	24.47	2,500	723	26.28	2,115
Averages, .	67.8	661	26.23	2,444	770	25.90	2,044

Weight of Sheep I. at beginning of period, ... 113.25 lbs.
Weight of Sheep II. at beginning of period, ... 117.25 "
Weight of Sheep I. at end of period, ... 112.75 "
Weight of Sheep II. at end of period, ... 117.75 "

Period IX.

[Food consumed daily: 650 grams hay (*a*), 200 grams King gluten meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
May 15,	60.5	645	28.45	3,008	682	28.71	1,838
16,	58.0	647	30.42	3,721	675	32.47	2,167
17,	64.0	677	29.57	1,968	670	27.60	2,123
18,	65.0	499	21.20	2,500	789	29.35	2,065
19,	64.5	653	28.27	2,406	673	26.47	1,869
20,	63.0	590	26.67	2,218	710	25.86	1,952
21,	57.0	657	29.26	2,252	810	28.93	2,016
Averages,	61.7	624	27.69	2,582	716	28.48	2,004

Weight of Sheep I. at beginning of period, ... 114.75 lbs.
Weight of Sheep II at beginning of period, . . . 118.00 "
Weight of Sheep I. at end of period, ... 116.50 "
Weight of Sheep II. at end of period, ... 119.25 "

Period X.

[Food consumed daily: 650 grams hay (*d*), 200 grams atlas meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
December 1,	32.0	610	34.89	57	994	33.00	1,103
2,	-	526	25.87	2,264	754	29.19	1,758
3,	41.0	606	30.06	968	671	24.72	936
4,	33.0	684	32.16	897	856	35.23	1,597
5,	31.5	635	30.22	873	747	33.49	730
6,	27.0	626	28.91	690	556	26.00	1,372
7,	33.0	692	29.05	1,397	624	29.22	1,292
Averages,	32.9	626	30.17	1,021	743	30.12	1,255

Weight of Sheep III. at beginning of period, ... 117.00 lbs.
Weight of Sheep IV. at beginning of period, ... 113.50 "
Weight of Sheep III. at end of period, ... 119.50 "
Weight of Sheep IV. at end of period, ... 117.50 "

Period XI.

[Food consumed daily: 550 grams hay (*d*), 300 grams peanut feed and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
October 28, .	48.0	820	42.72	988	762	46.61	750
29, .	57.0	788	43.03	1,213	808	46.38	1,068
30, .	51.0	813	44.49	928	766	43.47	2,038
31, .	56.5	792	40.17	1,150	735	42.39	25
November 1, .	52.5	784	42.29	1,285	685	38.81	1,677
2, .	60.0	773	40.53	994	777	41.89	875
3, .	59.0	852	45.43	1,080	704	38.98	1,912
Averages, .	54.9	803	42.67	1,091	748	42.65	1,192

Weight of Sheep III. at beginning of period, ... 114.50 lbs.
Weight of Sheep IV. at beginning of period, ... 113.00 "
Weight of Sheep III. at end of period, ... 115.00 "
Weight of Sheep IV. at end of period, ... 113.00 "

Period XII.

[Food consumed daily: 600 grams hay (*d*), 250 grams soja-bean meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep III.			Sheep IV.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
April 13, . .	46.0	697	26.70	1,828	629	25.40	1,705
14, . .	50.0	727	34.55	1,669	649	25.09	2,133
15, . .	55.5	559	29.00	1,280	729	36.68	1,886
16, . .	56.0	577	24.20	1,645	596	24.42	1,530
17, . .	59.5	679	28.17	2,066	603	22.84	2,091
18, . .	58.0	583	24.25	1,187	634	22.92	2,255
19, . .	60.0	705	29.45	1,905	697	26.39	2,322
Averages, .	55.0	647	28.05	1,654	648	26.25	1,989

Weight of Sheep III. at beginning of period, ... 114.00 lbs.
Weight of Sheep IV. at beginning of period, ... 113.50 "
Weight of Sheep III. at end of period, ... 112.75 "
Weight of Sheep IV. at end of period, ... 114.00 "

Period XIII.

[Food consumed daily: 550 grams hay (*d*), 300 grams rye meal and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
November 13, .	36.5	680	28.44	1,088	588	25.33	670
14, .	41.5	584	25.34	1,250	644	27.35	883
15, .	48.0	598	27.21	1,220	646	27.50	692
16, .	44.0	638	25.73	1,490	616	27.10	1,065
17, .	39.0	585	23.76	1,780	617	26.66	1,327
18, .	39.0	618	24.50	1,121	583	25.09	354
19, .	–	608	24.09	836	663	27.99	1,092
Averages, .	41.3	616	25.58	1,255	622	26.72	869

Weight of Sheep I. at beginning of period, ... 113.00 lbs.
Weight of Sheep II. at beginning of period, ... 113.00 "
Weight of Sheep I. at end of period, ... 113.00 "
Weight of Sheep II. at end of period, ... 113.00 "

Period XIV.

[Food consumed daily: 600 grams hay (*a*), 300 grams winter wheat bran and 5 grams salt.]

Date.	Stable Temperature (Fahr.).	Sheep I.			Sheep II.		
		Manure excreted Daily.	Sample Air Dry.	Water drank Daily.	Manure excreted Daily.	Sample Air Dry.	Water drank Daily.
1894.	Degrees.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
April 13, . .	46.0	1,181	38.21	1,644	1,017	31.64	1,669
14, . .	50.0	989	31.82	1,869	1,093	34.24	1,523
15, . .	55.5	1,002	33.28	2,225	983	30.62	2,061
16, . .	56.0	978	32.47	2,108	1,116	33.30	2,009
17, . .	59.5	1,080	34.40	2,145	1,172	34.45	1,803
18, . .	58.0	959	32.19	2,161	1,124	33.09	1,847
19, . .	60.0	1,057	33.40	2,304	1,167	32.48	2,193
Averages, .	55.0	1,035	33.68	2,065	1,096	32.83	1,872

Weight of Sheep I. at beginning of period, ... 114.25 lbs.
Weight of Sheep II. at beginning of period, ... 117.00 "
Weight of Sheep I. at end of period, ... 113.75 "
Weight of Sheep II. at end of period, ... 117.00 "

The data presented in the preceding tables enable us to calculate the digestion coefficients, which follow : —

Period I.

English Hay (a).

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed,	796.32	255.53	25.72	88.94	369.64
72 grams waste,	60.69	18.74	2.08	7.41	25.84
Total consumed,	735.63	236.79	23.64	81.53	343.80
342.71 grams manure air dry,	309.47	92.59	12.03	34.69	142.16
Grams digested,	426.16	144.20	11.61	46.84	201.64
Per cent. digested,	57.93	60.90	49.11	57.45	58.65

Sheep II.

900 grams hay fed,	796.32	255.53	25.72	88.94	369.64
368.66 grams manure air dry,	330.54	99.03	12.39	38.14	153.30
Grams digested,	465.78	156.50	13.33	50.80	216.34
Per cent. digested,	58.49	61.24	51.82	57.11	58.52

Sheep III.

900 grams hay fed,	796.32	255.53	25.72	88.94	369.64
73 grams waste,	62.34	20.04	1.93	7.08	27.06
Total consumed,	733.98	235.49	23.79	81.86	342.58
337.27 grams manure air dry,	307.02	88.85	13.35	36.07	140.19
Grams digested,	426.96	146.64	10.44	45.79	202.39
Per cent. digested,	58.17	62.27	43.88	55.88	59.07

Sheep IV.

900 grams hay fed,	796.32	255.53	25.72	88.94	369.64
328.91 grams manure air dry,	306.02	88.62	11.90	33.35	143.89
Grams digested,	490.30	166.91	13.82	55.59	225.75
Per cent. digested,	61.57	65.32	53.73	62.49	61.07
Average per cent. digested,	**59.04**	**62.44**	**49.63**	**58.23**	**59.33**

Average nutritive ratio of ration for four sheep, 1 : 8.00.

Period II.

English Hay (b).

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams hay fed,	790.30	256.84	18.10	76.97	375.24
399.76 grams manure air dry,	364.34	114.19	9.65	32.97	166.00
Grams digested,	425.96	142.65	8.45	44.00	209.24
Per cent. digested,	53.89	55.54	46.67	57.16	55.76

Sheep II.

900 grams hay fed,	790.30	256.84	18.10	76.97	375.24
395.43 grams manure air dry,	361.15	109.79	9.29	36.76	162.27
Grams digested,	429.15	147.06	8.81	40.21	212.97
Per cent. digested,	54.33	57.25	48.65	52.23	56.76

English Hay (c).

Sheep III.

900 grams hay fed,	795.60	265.96	20.21	77.49	374.01
392.01 grams manure air dry,	360.26	113.60	11.06	33.07	164.10
Grams digested,	435.34	152.36	9.15	44.42	209.91
Per cent. digested,	54.72	57.30	45.28	57.32	56.12

Sheep IV.

900 grams hay fed,	795.60	265.96	20.21	77.49	374.01
378.69 grams manure air dry,	348.44	108.92	10.41	31.15	156.38
Grams digested,	447.16	157.04	9.80	46.34	217.63
Per cent. digested,	56.20	59.04	48.50	59.82	58.19
Average per cent. digested,	54.94	57.29	46.82	58.10	56.69

Average nutritive ratio of ration for Sheep I., III. and IV., 1 : 8.59.

Hays *b* and *c* were from the same lot, but the tests were made at different times and two separate samples were taken. The average of the analyses of the two analyses and of the digestion coefficients from Sheep I., III. and IV. was used in computing the digestibility of the grains fed. This average

has been called hay *d*. Sheep II., while the results are given above, was not included in the average. The period in case of this sheep lasted but three days, and the amount of protein digested is too low.

Period III.

Vetch and Oats.

Sheep III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams vetch and oats fed, . .	766.08	275.41	19.99	102.81	286.30
364.5 grams manure air dry, . .	321.21	95.98	16.64	40.18	130.48
Grams digested, ...	444.87	179.43	3.35	62.63	155.82
Per cent. digested, ...	58.07	65.16	16.75	60.92	54.42

Sheep IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
900 grams vetch and oats fed, . .	766.08	275.41	19.99	102.81	286.30
353.4 grams manure air dry, . .	320.68	91.17	15.91	42.68	132.06
Grams digested, ...	445.40	184.24	4.08	60.13	154.24
Per cent. digested, ...	58.14	66.88	20.40	58.48	53.88
Average per cent. digested, . . .	**58.10**	**66.02**	**18.57**	**59.70**	**54.15**

Average nutritive ratio of ration for two sheep, 1 : 5.64.

Period IV.

New-process Linseed Meal.

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	516.00	165.50	16.66	57.63	239.42
200 grams new-process linseed meal, .	178.80	14.38	7.68	73.98	71.98
Total consumed, ...	694.80	179.88	24.34	131.61	311.40
271.04 grams manure air dry, . .	252.06	75.06	8.21	36.54	107.02
Amount digested, . . .	442.74	104.82	16.13	95.07	204.38
Minus hay digested, ...	304.63	103.39	8.27	33.57	142.04
Remains linseed meal digested, . .	138.11	1.43	7.86	61.50	62.34
Per cent. digested, ...	77.24	99.47	102.20?	83.12	86.60

Nutritive ratio of ration for one sheep, 1 : 3.68.

Period V.

Buffalo Gluten Feed.

Sheep III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.68	166.12	16.72	57.82	240.31
250 grams Buffalo gluten feed, . .	229.82	19.44	30.61	52.69	126.15
Total consumed, ...	747.50	185.56	47.33	110.51	366.46
253.11 grams manure air dry, . .	236.61	63.43	10.64	30.10	111.70
Total digested, ...	510.89	122.13	36.69	80.41	254.76
Minus hay digested, ...	305.64	103.72	8.30	33.67	142.57
Remains gluten feed digested, . .	205.25	18.41	28.39	46.74	112.19
Per cent. digested, ...	89.35	94.69	92.74	88.69	88.93

Sheep IV.

Total consumed, as above, . .	747.50	185.56	47.33	110.51	366.46
249.43 grams manure air dry, . .	232.46	61.51	9.76	30.00	110.65
Total digested, ...	515.04	124.05	37.57	80.51	255.81
Minus hay digested, ...	305.64	103.72	8.30	33.67	142.57
Remains gluten feed digested, . .	209.40	20.33	29.27	46.84	113.24
Per cent. digested, ...	91.11	104.56?	95.61	88.88	89.76
Average per cent. two sheep digested,	**90.23**	**99.60**	**94.17**	**88.78**	**89.34**

Average nutritive ratio of ration for two sheep, 1 : 5.85.

Period VI.

Peoria Gluten Feed.

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	486.20	160.30	11.76	47.35	229.97
250 grams Peoria gluten feed, . .	225.20	18.69	14.12	43.32	147.16
Total consumed, ...	711.40	178.99	25.88	90.67	377.13
277.61 grams manure air dry, . .	254.96	76.19	8.84	27.89	114.64
Amount digested, ...	456.44	102.80	17.04	62.79	262.49
Minus hay digested, ...	267.11	91.83	5.51	27.51	130.37
Remains gluten feed digested, . .	189.33	10.97	11.53	35.28	132.12
Per cent. digested, ...	84.07	58.69	81.63	81.42	89.77

PERIOD VI. (*Peoria Gluten Feed*) — Concluded.

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed,	523.20	172.50	12.66	50.96	247.47
250 grams Peoria gluten feed,	224.30	18.62	14.06	43.15	146.58
Total consumed,	747.50	191.12	26.72	94.11	394.05
278.76 grams manure air dry,	264.49	74.16	10.16	28.03	121.85
Amount digested,	483.01	116.96	16.56	66.08	272.20
Minus hay digested,	287.44	98.82	5.93	29.60	140.29
Remains gluten feed digested,	195.57	18.14	10.63	36.48	131.91
Per cent. digested,	87.19	97.44	75.58	84.53	89.99
Average per cent. two sheep digested,	**85.63**	**78.06**	**78.60**	**82.97**	**89.88**

Average nutritive ratio of ration for two sheep, 1 : 6.50.

PERIOD VII.

Chicago Maize Feed.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed,	518.94	166.52	16.76	57.96	240.89
250 grams Chicago maize feed,	224.30	20.32	20.19	58.60	123.39
Total consumed,	743.24	186.84	36.95	116.56	364.28
261.96 grams manure air dry,	239.27	65.29	10.26	33.04	110.90
Amount digested,	503.97	121.55	26.69	83.52	253.38
Minus hay digested,	306.38	103.98	8.32	33.75	142.92
Remains gluten feed digested,	197.59	17.57	18.37	49.77	110.46
Per cent. digested,	88.09	86.45	91.00	84.92	89.52

SHEEP IV.

Total consumed, as above,	743.24	186.84	36.95	116.56	364.28
266.19 grams manure air dry,	243.53	66.92	10.05	32.41	114.97
Total digested,	499.71	119.92	26.90	84.15	249.31
Minus hay digested,	306.38	103.98	8.32	33.75	142.92
Remains gluten feed digested,	193.33	15.94	18.58	50.40	106.39
Per cent. digested,	86.19	78.48	92.03	86.00	86.22
Average per cent. two sheep digested,	**87.14**	**82.46**	**91.51**	**85.46**	**87.87**

Average nutritive ratio of ration for two sheep, 1 : 5.25.

Period VIII.

Chicago Gluten Meal.

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed,	560.82	179.96	18.11	62.64	260.33
200 grams Chicago gluten meal,	180.60	3.12	8.30	66.98	101.93
Total consumed,	741.42	183.08	26.41	129.62	362.26
262.27 grams manure air dry,	244.62	69.49	9.44	33.85	109.78
Total digested,	496.80	113.59	16.97	95.77	252.48
Minus hay digested,	331.11	112.37	8.99	36.47	154.45
Remains gluten meal digested,	165.69	1.22	7.98	59.30	98.03
Per cent. digested,	91.74	39.04	96.05	88.52	96.17

Sheep II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above,	741.42	183.08	26.41	129.62	362.26
258.84 grams manure air dry,	241.08	70.58	9.26	31.19	108.68
Total digested,	500.34	112.50	17.15	98.43	253.58
Minus hay digested,	331.11	112.37	8.99	36.47	154.45
Remains gluten meal digested,	169.23	.13	8.16	61.96	99.13
Per cent. digested,	93.70	4.16	98.22	92.49	97.25
Average per cent. two sheep digested,	**92.72**	**21.60**	**97.13**	**90.50**	**96.71**

Average nutritive ratio of ration for two sheep, 1 : 4.21.

Period IX.

King Gluten Meal.

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed,	562.18	180.40	18.15	62.79	260.96
200 grams King gluten meal,	183.24	2.58	36.06	70.67	71.17
Total consumed,	745.42	182.98	54.21	133.46	332.13
276.91 grams manure air dry,	254.12	69.32	12.02	32.22	116.41
Amount digested,	491.30	113.66	42.19	101.24	215.72
Minus hay digested,	331.91	112.64	8.97	36.56	154.82
Remains gluten meal digested,	159.39	1.02	33.22	64.68	60.90
Per cent. digested,	86.98	39.47	92.12	91.52	85.57

PERIOD IX. (*King Gluten Meal*) — Concluded.

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	745.42	182.98	54.21	133.46	332.13
284.84 grams manure air dry, . .	259.68	75.85	10.05	31.65	118.60
Amount digested, ...	485.74	107.13	44.16	101.81	213.53
Minus hay digested, ...	331.91	112.64	8.96	36.56	154.82
Remains gluten meal digested, . .	153.83	-	35.20	65.25	58.71
Per cent. digested, ...	83.96	-	97.63	92.34	82.44
Average per cent. two sheep digested,	**85.47**	-	**94.87**	**91.93**	**84.00**

Average nutritive ratio of ration for two sheep, 1 : 4.26.

PERIOD X.

Atlas Meal.

SHEEP III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
650 grams hay fed, ...	550.35	181.45	13.31	53.60	260.32
200 grams atlas meal, ...	182.08	17.72	28.70	77.62	56.15
Total consumed, ...	732.43	199.17	42.01	131.22	316.47
301.66 grams manure air dry, . .	285.25	78.41	9.24	43.38	121.72
Total digested, ...	447.18	120.76	32.77	87.84	194.75
Minus hay digested, ...	302.36	103.95	6.23	31.14	147.58
Remains atlas meal digested, . .	144.82	16.81	26.54	56.70	47.17
Per cent. digested, ...	79.53	94.88	92.43	73.04	84.00

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	732.43	199.17	42.01	131.22	316.47
301.21 grams manure air dry, . .	284.52	74.57	9.92	43.76	121.21
Total digested, ...	447.91	124.60	32.09	87.46	195.26
Minus hay digested, ...	302.36	103.95	6.23	31.14	147.58
Remains atlas meal digested, . .	145.55	20.65	25.86	56.32	47.68
Per cent. digested, ...	79.75	116.50	90.06	72.56	84.91
Average per cent. two sheep digested,	**79.64**	**105.70**	**91.24**	**72.80**	**84.45**

Average nutritive ratio of ration for two sheep, 1 : 4.55.

Period XI.

Peanut Feed.

Sheep III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed, ...	483.17	159.30	11.69	47.06	228.54
300 grams peanut feed, ...	271.29	147.58	15.03	32.72	62.23
Total consumed, ...	754.46	306.88	26.72	79.78	290.77
426.66 grams manure air dry, . .	402.39	201.03	7.72	29.17	125.41
Total digested, ...	352.07	105.85	19.00	50.61	165.36
Minus hay digested, ...	265.45	91.26	5.47	27.34	129.56
Remains peanut feed digested, . .	86.62	14.59	13.53	23.27	35.80
Per cent. digested, ...	31.93	9.88	90.01	71.12	57.52

Sheep IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	754.46	306.88	26.72	79.78	290.77
426.47 grams manure air dry, . .	401.48	195.70	7.82	29.59	135.95
Total digested, ...	352.98	111.18	18.90	50.19	154.82
Minus hay digested, ...	265.45	91.26	5.47	27.34	129.56
Remains peanut feed digested, . .	87.53	19.92	13.43	22.85	25.26
Per cent. digested, ...	32.26	13.49	89.36	70.00	40.59
Average per cent. two sheep digested,	**32.09**	**11.68**	**89.68**	**70.56**	**49.05**

Average nutritive ratio of ration for two sheep, 1 : 6.27.

Period XII.

Soja-bean Meal.

Sheep III.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.86	166.18	16.72	57.84	240.29
250 grams soja-bean meal, . . .	225.55	10.15	42.61	86.69	72.04
Total consumed, ...	743.41	176.33	59.33	144.53	312.33
280.46 grams manure air dry, . .	261.39	67.67	16.36	32.78	115.27
Total digested, ...	482.02	108.66	42.97	111.75	197.06
Minus hay digested, ...	305.75	103.76	8.34	33.68	142.62
Remains soja-bean meal digested, .	176.27	4.90	34.63	78.07	54.44
Per cent. digested, ...	78.15	48.27	81.28	89.97	75.57

PERIOD XII. (*Soja-bean Meal*) — Concluded.

SHEEP IV.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above,	743.41	176.33	59.33	144.53	312.33
262.49 grams manure air dry,	244.64	63.02	12.65	30.85	114.22
Total digested,	498.77	113.31	46.68	113.68	198.11
Minus hay digested,	305.73	103.76	8.30	33.68	142.62
Remains soja-bean meal digested,	193.04	9.55	38.38	80.00	55.49
Per cent. digested,	85.58	94.09	90.09	92.20	77.02
Average per cent. two sheep digested,	**81.86**	**71.18**	**85.68**	**91.08**	**76.29**

Average nutritive ratio of ration for two sheep, 1 : 3.73.

PERIOD XIII.

Rye Meal.

SHEEP I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
550 grams hay fed,	479.60	158.12	11.61	46.71	226.85
300 grams rye meal,	257.22	4.60	4.60	35.04	209.97
Total consumed,	736.82	162.72	16.21	81.75	436.82
255.81 grams manure air dry,	242.89	73.00	7.77	25.35	109.86
Total digested,	493.73	89.72	8.44	56.40	326.96
Minus hay digested,	263.49	90.58	5.43	27.14	128.60
Remains rye meal digested,	230.24	-	3.01	29.26	198.36
Per cent. digested,	89.51	-	65.37	83.46	94.47

SHEEP II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above,	736.82	162.72	16.21	81.75	436.82
267.15 grams manure air dry,	254.21	74.96	7.88	24.70	120.60
Total digested,	482.61	87.76	8.33	57.05	316.22
Minus hay digested,	263.49	90.58	5.43	27.14	128.60
Remains rye meal digested,	219.12	-	2.90	29.91	187.62
Per cent. digested,	85.18	-	62.98	85.31	89.34
Average per cent. two sheep digested,	**87.34**	-	**64.17**	**84.38**	**91.90**

Average nutritive ratio of ration for two sheep, 1 : 7.60.

Period XIV.

Winter Wheat Bran.

Sheep I.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
600 grams hay fed, ...	517.86	166.18	16.72	57.84	240.29
300 grams winter wheat bran, . .	258.81	27.53	12.86	40.40	158.37
Total consumed, ...	776.67	193.71	29.58	98.24	398.66
336.73 grams manure air dry, . .	313.86	88.47	14.46	33.17	141.93
Total digested, ...	462.81	105.24	15.12	65.07	256.73
Minus hay digested, ...	305.75	103.76	8.30	33.68	142.62
Remains winter wheat bran digested,	157.06	1.48	6.82	31.39	114.11
Per cent. digested, ...	60.68	5.37	53.02	77.69	72 05

Sheep II.

	Dry Matter.	Crude Cellulose.	Crude Fat.	Crude Protein.	Extract Matter.
Total consumed, as above, . .	776.67	193.71	29.58	98.24	398.66
328.31 grams manure air dry, . .	305.69	83.54	10.94	32.80	142.39
Total digested, ...	470.98	110.17	18.64	65.44	256.27
Minus hay digested, ...	305.75	103.76	8.30	33.68	142.62
Remains winter wheat bran digested,	165.23	6.41	10.34	31.76	113.65
Per cent. digested, ...	63.83	23.29	80.39	78.65	71.76
Average per cent. two sheep digested,	62.25	14.33	66.70	78.17	71.90

Average nutritive ratio of ration for two sheep, 1 : 6.23.

See tables containing compilation of all American digestion experiments, at the end of this report.

2. CONCERNING THE DIGESTIBILITY OF THE PENTOSANS.

By J. B. Lindsey and E. B. Holland.

During the past five or six years much attention has been given to the study of the pentosans. Fischer, Tollens, Schulze, Stone and many others have investigated their chemical character, and noted their very general occurrence in our woods and agricultural plants and seeds.

The pentosans have the composition $(C_5H_8O_4)n$, and by inversion with dilute mineral acids yield, so far as known, two sugars, namely, *xylose* and *arabinose*, $C_5H_{10}O_5$. The pentosan which yields xylose is more generally found in our agricultural plants. Pentoses * $(C_5H_{10}O_5)$ have been found to exist in the juices of a great variety of growing plants. Whether they are formed by direct assimilation, or from the hexoses, is not yet fully settled. Xylan and araban belong, generally speaking, to the so-called *hemicelluloses*. E. Schulze † has applied this name to those portions of the cellular structure of plants that are not soluble in water, but in dilute mineral acids. That they cannot always be strictly considered as hemicellulose is made clear from the recognition by Schulze and Winterstein ‡ of a pentosan in *amyloid*, a substance extracted with water from the seeds of *Tropæolum majus*. In some cases, also, they approach in character the true cellulose.§ Schulze ‖ has also recognized the pentosans in the cotyledons and endosperms of many seeds, and they undoubtedly serve, just as do galactan, starch, etc., as a reserve material, supporting the life of the young plant

* G. de Chalmot, Am. Chem. Jour., **15**, 21.

† Zeitschr. f. physiol. Chemie, **14**.

‡ Zeitschr. f. physiol. Chemie, **15**; Berichte der chem. Ges., **24**, 2277.

§ Zeitschr. f. physiol. Chemie, **16**; also Winterstein *loco citato*.

‖ *Loco citato*.

during the process of germination. That the pentosans in the matured plants and seeds form a part of the cell walls and are dissolved during germination is quite clear from the numerous microscopic investigations made by Professor Cramer * and Dr. Pfister † in connection with Schulze's work.

Concerning the value of the pentosans as a source of food for animals, the results of two investigations have been published. Stone ‡ fed corn meal and bran to rabbits, and found that about 60 per cent. of the pentosans were digested. A like conclusion was drawn by Stone and Jones, § as a result of the examination of the food and fæces of sheep fed upon the hay of different grasses. Ebstein ‖ has also shown that both xylose and arabinose are but little assimilated by human beings, these sugars being recognized in the urine a few hours after being eaten.

During the spring and autumn of 1893 the writer made digestion experiments with hay, corn cobs, brewers' grains and several concentrated fodder articles. These results have already been published.¶ We have thought it of sufficient interest to determine the amount of pentosans in each of the foods fed and in the fæces excreted, and thus note their degree of digestibility.**

The method employed for determining the furfurol, and consequently the pentosans, was the one described by Flint and Tollens, †† being a modification of the method originally introduced by de Chalmot and Tollens. ‡‡

Pentosans differ from true carbohydrates in yielding furfurol instead of lævulinic acid when boiled with hydrochloric

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* Zeitschr. physiol. Chem., **14**, 227

† Zeitschr. physiol. Chem., **19**, 41.

‡ Am. Chem. Jour., **14**, 9.

§ Agricultural Science, **5**, 6.

‖ Archiv. pathol. Anat., **129**, 401.

¶ Massachusetts State Experiment Station, Eleventh Annual Report, 1893.

** While it is possible to estimate the amount of furfurol in the fæces with a fair degree of accuracy, it must be admitted that it is by no means certain that this furfurol is a true indicator of the amount of pentosans present; *i.e.*, it has not as yet been shown whether the pentosan molecule remains entirely intact during the digestive process. From our present knowledge it must be assumed that such is the case.

†† E. R. Flint, Inaugural Dissertation, Göttingen, 1892; Landw. Vers. Stat., **42**, 398.

‡‡ Inaugural Dissertation, Göttingen, 1891

acid of a certain strength. Their detection and estimation depends upon the production and separation of furfurol, and its subsequent precipitation with phenyl-hydrazin as furfurol hydrazon.

Method.

Weigh out 3 to 5 grams (depending on the amount of pentosans present) of the finely ground material, and transfer to a 300 cubic centimeter flask. After adding 100 cubic centimeters of hydrochloric acid of 1.06 specific gravity, connect with a Liebig condenser, and distil 30 cubic centimeters, taking ten to fifteen minutes for the distillation. Instead of putting the flask in Rose's metal to diffuse the heat, as Flint and others suggest, we have placed it upon a piece of gauze with equally satisfactory results. Now add 30 cubic centimeters more acid by means of a separatory funnel (the stem of which passes through the cork into the flask), and so continue the process until a drop of the distillate gives no red coloration on filter paper that has been moistened with aniline acetate (a few drops of aniline in a little 50 per cent. acetic acid). Ten to eleven distillations are generally sufficient. Flint has shown that for constant results the presence of a certain amount of salt in a definite quantity of solution is essential. Furfurol hydrazon is more insoluble with 81 grams of sodium chloride in 400 cubic centimeters of distillate than when less is present, and these proportions should be always used. Add to the obtained distillate, brought into a 700 to 800 cubic centimeter beaker, the necessary amount of salt and water to raise it to this standard (see table following).

Distillate (Cubic Centimeters).	Water (Cubic Centimeters).	Salt to be added (Grams).	Distillate (Cubic Centimeters).	Water (Cubic Centimeters).	Salt to be added (Grams).
400	–	–	150	250	50.75
350	50	10.15	100	300	60.90
300	100	20.30	50	350	71.05
250	150	30.45	–	400	81.20
200	200	40.60			

Neutralize exactly the 400 cubic centimeter solution with sodium carbonate, covering the beaker with a watch glass during the process, and make up to 500 cubic centimeters with water. Add now 10 cubic centimeters of phenyl-hydrazin solution,* precipitating the furfurol as furfurol hydrazon.† Stir thirty minutes, preferably with an automatic stirrer, and filter the solution, using suction, into glass drying tubes about three-quarters of an inch in diameter and six to seven inches long, drawn out at the lower end and filled with about one-half inch of glass wool in preference to asbestos. Remove adhering particles with a feather, and do not use over 100 cubic centimeters of wash water. Dry the precipitate in a specially constructed air bath (see cut) at 55° to 60° C. for three hours. To hasten and perfect the drying a partial vacuum is made by drawing dry air slowly through the tubes by aid of a suction pump, the air supply being regulated by pinchcocks. The air before entering the tubes is conducted through sulphuric acid to dry it, and through a glass tube containing small pieces of marble to remove any sulphuric acid that might be carried over mechanically. Cool the tubes in a desiccator and weigh. Dissolve out the precipitate with hot alcohol and reweigh, and consider the loss in weight as furfurol hydrazon. (See cut of apparatus at end of this article.)

For the conversion of furfurol hydrazon to furfurol use the following factors : —

Furfurol = furfurol hydrazon $\times$ 0.538.
Arabinose = furfurol hydrazon $\times$ 1.229 + 0.0177.
Xylose = furfurol hydrazon $\times$ 1.031 — 0.001.
Pentose (average arabinose and xylose) = furfurol hydrazon $\times$ 1.13 + 0.0083.
Pentosan = pentose $\times$ 0.88.

Formulas.

Furfurol = $C^4 H^3 O - C O H$.
Phenyl-hydrazin = $C^6 H^5 - NH - NH^2$.
Furfurol hydrazon = $C^4 H^3 O CH C^6 H^5 N^2 H$.
Pentose = $(C^5 H^{10} O^5)$ n.
Pentosans = $(C^5 H^8 O^4)$ n.

* Twelve grams of phenyl-hydrazin and 7.5 grams of glacial acetic acid filled to 100 cubic centimeters with water and well shaken.

† After the addition of the phenyl-hydrazin reagent, the solution should react *slightly* acid. In case this is not so, add the necessary acetic acid.

In Table I. will be found the percentages of furfurol, pentosans and extract matter found in the feeds consumed. It will be seen that the pentosans equal from one-third to one-half of the extract matter.

Table II. shows the percentages of pentosans in the excreta of the sheep during the different feeding periods.

TABLE I. — *Pentosans in Food tested.**

No. of Period.	Foods Tested.	Dry Matter (Per Cent.).	No. of Grams taken for Furfurol Estimation.	Air-dry Material. Furfurol Hydrazon found (Grams).		Dry Matter. Equivalent Per Cent. Furfurol.	Dry Matter. Equivalent Per Cent. Pentosans.	Dry Matter. Per Cent. Nitrogen-free Extract.
				a.	*b.*			
1	Hay (*a*),	94.09	4	0.7633	0.7656	10.93	20.41	48.51
2	Buffalo gluten feed,	92.92	5	0.7968	0.7913	9.20	17.16	50.20
3	Hay (*b*),	93.63	3	0.6140	0.6393	12.00	22.43	45.56
4	New-process linseed meal,	91.75	4	0.4860	0.4950	7.19	13.49	41.16
5	Old-process linseed meal,	90.81	4	0.4807	0.4916	6.54	13.49	39.80
6	Corn cobs,	92.27	3	0.8643	0.8651	16.80	31.34	65.77
7	Dried brewers' grains,	93.46	4	0.9205	0.9111	13.17	24.57	51.09
8	Spring wheat bran,	92.72	3	{ 0.8188 / 0.7902 }	0.8111	15.60	29.07	59.39
9	Winter wheat bran,	91.49	3	{ 0.6877 / 0.6675 }	0.6620	13.17	24.63	62.83

* In a former article, published in "Agricultural Science," concerning the digestibility of the pentosans, the percentages of pentosans were calculated by multiplying the per cent. of furfurol by 1.38. This was the old way, and if none of the pentosans were destroyed in the process of distillation it would give the correct percentage. It gives, however, considerably lower percentages than when the formula as suggested by Flint is used. The digestion coefficients would not be affected, however. In the present calculations we have used Flint's formula, believing it to be much nearer correct.

TABLE II. — *Pentosans in Manure excreted.*

No. of Period.	Foods Tested.	Dry Matter (Per Cent.).	Grams taken for Furfurol Estimation.	Air-dry Material. Furfurol Hydrazon found (Grams).		Dry Matter. Equivalent Per Cent. Furfurol.	Dry Matter. Equivalent Per Cent. Pentosans.
				a.	b.		
	Hay (a).						
I.	Sheep II.,	92.96	4	0.6996	0.7210	10.27	19.20
	Sheep III.,	93.33	4	0.6990	0.7060	10.12	18.92
	Sheep IV.,	92.34	4	0.7395	0.7358	10.74	20.08
	Buffalo Gluten Feed.						
II.	Sheep II.,	91.54	5	0.8520	0.8620	10.07	18.76
	Sheep IV.,	92.20	5	0.8758	0.8824	10.26	19.13
	Hay (b).						
III.	Sheep I.,	93.00	4	0.6880 / 0.6920	0.7190	10.10	18.91
	Sheep II.,	92.59	4	0.7390	0.7310	10.67	19.94
	Sheep III.,	92.38	4	0.6804	0.7149	10.15	18.98
	Sheep IV.,	91.74	4	0.6657	0.6596	9.71	18.16
	New-process Linseed Meal.						
IV.	Sheep II.,	94.62	3	0.5210	0.5165	9.83	18.45
	Sheep III.,	94.57	4	0.6387	–	9.08	16.97
	Old-process Linseed Meal.						
V.	Sheep II.,	94.62	4	0.6762	0.6476	9.41	17.60
	Sheep III.,	94.48	4	0.6677	0.6390	9.29	17.40
	Sheep IV.,	94.90	4	0.6520	0.6415	9.17	17.15
	Corn Cobs.						
VI.	Sheep I.,	93.25	3	0.5940	0.5950	11.43	21.40
	Sheep II.,	92.71	3	0.6057	0.6140	11.80	22.08
	Dried Brewers' Grains.						
VII.	Sheep I.,	95.51	4	0.8705	0.8500	12.20	22.60
	Sheep II.,	94.43	4	0.8756	0.8817	12.52	23.34
	Spring Wheat Bran.						
VIII.	Sheep II.,	94.76	4	0.8573	0.8623	12.20	22.76
	Sheep III.,	94.73	4	0.8240	0.8400	11.82	22.04
	Winter Wheat Bran.						
IX.	Sheep IV.,	95.43	4	0.7810	0.7730	10.94	20.45

The data furnished in the above tables enable us to calculate the digestibility of the pentosans, as found in the tables following: —

Digestibility of Pentosans. — *Period I. English Hay.*

Sheep II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep III. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep IV. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
749 28 grams hay eaten,	152.93	754.12 grams hay eaten,	153.91	769.50 grams hay eaten,	157.05
294.67 grams manure excreted,	56.58	286.50 grams manure excreted,	54.20	296.78 grams manure excreted,	59.59
Grams pentosans digested,	96.35	Grams pentosans digested,	99.71	Grams pentosans digested,	97.46
Per cent. pentosans digested,	63.00	Per cent. pentosans digested,	64.80	Per cent. pentosans digested,	62.10
Average per cent. pentosans digested (three sheep),				63.30	

Period II. — Buffalo Gluten Feed.

Sheep II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep IV. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
491.35 grams hay fed,	100.28	528 30 grams hay fed,	107.83
271.77 grams Buffalo gluten fed,	46.64	225.00 grams Buffalo gluten fed,	38.61
Total consumed,	146.92	Total consumed,	146 44
259.73 grams manure excreted,	48.73	247.77 grams manure excreted,	47.40
Grams digested,	98.19	Total digested,	99.04
Minus pentosans digested in hay,	63 18	Minus pentosans digested in hay,	66.96
Grams pentosans digested,	35.01	Grams pentosans digested,	32.08
Per cent. pentosans digested,	75.10	Per cent. pentosans digested,	83.10
Average per cent. pentosans digested (two sheep),		79.10	

Period III. — Hay (b).

Sheep I. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
765.36 grams hay fed,	171.67	765.36 grams hay fed,	171.67
337.95 grams manure excreted,	63.91	343.62 grams manure excreted,	68.52
Grams pentosans digested,	107.76	Grams pentosans digested,	103.15
Per cent. pentosans digested,	62.70	Per cent. pentosans digested,	60.10

Sheep III. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep IV. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
765.36 grams hay fed,	171.67	765.36 grams hay fed,	171.67
339.33 grams manure excreted,	64.40	337.83 grams manure excreted,	61.35
Grams pentosans digested,	107.27	Grams pentosans digested,	110.32
Per cent. pentosans digested,	62.50	Per cent. pentosans digested,	64.30

Average per cent. pentosans digested (four sheep), . . . 62.40

Period IV. — New-process Linseed Meal.

Sheep II. Daily Statement. — Dry Matter.	Sheep II. Pentosans in Food consumed and Manure excreted.	Sheep III. Daily Statement. — Dry Matter.	Sheep III. Pentosans in Food consumed and Manure excreted.
526.38 grams hay fed,	118.07	526.38 grams hay fed,	118.07
220.70 grams new-process linseed meal fed,	29.79	220.70 grams new-process linseed meal fed,	29.79
Total consumed,	147.86	Total consumed,	147.86
280.76 grams manure excreted,	51.80	271.77 grams manure excreted,	46.12
Grams digested,	96.06	Grams digested,	101.74
Minus pentosans digested in hay,	70.96	Minus pentosans digested in hay,	73.78
Grams pentosans digested,	25.10	Grams pentosans digested,	27.96
Per cent. pentosans digested,	84.30	Per cent. pentosans digested,	93.90
Average per cent. pentosans digested (two sheep),			89.10

Period V. — Old-process Linseed Meal.

Sheep II. Daily Statement. — Dry Matter.	Sheep II. Pentosans in Food consumed and Manure excreted.	Sheep III. Daily Statement. — Dry Matter.	Sheep III. Pentosans in Food consumed and Manure excreted.	Sheep IV. Daily Statement. — Dry Matter.	Sheep IV. Pentosans in Food consumed and Manure excreted.
517.38 grams hay fed,	116.05	517.38 grams hay fed,	116.05	526.38 grams hay fed,	118.07
218.18 grams old-process linseed meal fed,	29.45	218.18 grams old-process linseed meal fed,	29.45	220.00 grams old-process linseed meal fed,	29.70
Total consumed,	145.50	Total consumed,	145.50	Total consumed,	147.77
285.76 grams manure excreted,	50.29	268.10 grams manure excreted,	46.65	280.20 grams manure excreted,	48.05
Total digested,	95.21	Total digested,	98.85	Total digested,	99.72
Minus pentosans digested in hay,	69.75	Minus pentosans digested in hay,	72.53	Minus pentosans digested in hay,	75.92
Grams pentosans digested,	25.46	Grams pentosans digested,	26.32	Grams pentosans digested,	23.80
Per cent. pentosans digested in hay,	86.40	Per cent. pentosans digested in hay,	89.40	Per cent. pentosans digested in hay,	80.10
Average per cent. pentosans digested (three sheep),					85.30

Period VI. — Corn Cobs.

Sheep I. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
384.03 grams hay fed,	86.14	334.48 grams hay fed,	75 02
351.56 grams corn cobs fed,	110.17	351.56 grams corn cobs fed,	110.18
220.25 grams new-process linseed meal fed,	29.73	177.14 grams new-process linseed meal fed,	23.91
Total consumed,	226.05	Total consumed,	209.11
353.05 grams manure excreted,	75 55	331.73 grams manure excreted,	73 25
Total digested,	150 50	Total digested,	135.86
Minus pentosans in hay and linseed meal digested,	80.49	Minus pentosans in hay and linseed meal digested,	65.25
Grams pentosans digested,	70.01	Grams pentosans digested,	70.61
Per cent. pentosans digested,	63.50	Per cent. pentosans digested,	64.10
Average per cent. pentosans digested (two sheep),		63.80	

Period VII. — Dried Brewers' Grains.

Sheep I. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
433.00 grams hay consumed,	97.12	433.00 grams hay consumed,	97.12
358.72 grams brewers' grain consumed,	88.14	358.72 grams brewers' grain consumed,	88.14
Total consumed,	185.26	Total consumed,	185.26
328.83 grams manure excreted,	74.32	331.87 grams manure excreted,	77.45
Total digested,	110.94	Total digested,	107 81
Minus pentosans in hay digested,	60.89	Minus pentosans in hay digested,	58.37
Grams pentosans digested,	50.05	Grams pentosans digested,	49.44
Per cent. pentosans digested,	56.80	Per cent. pentosans digested,	56.10
Average per cent. pentosans digested (two sheep),		56.40	

Period VIII. — Spring Wheat Bran.

Sheep II. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.	Sheep III. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
523.44 grams hay fed,	117.41	523.44 grams hay fed,	117.41
261.93 grams spring bran fed,	76.14	261.93 grams spring bran fed.	76.14
Total fed,	193.55	Total fed,	193.55
333.84 grams manure excreted,	75.98	329 49 grams manure excreted,	72.62
Total digested,	117.57	Total digested,	120.93
Minus pentosans in hay digested,	70.56	Minus pentosans in hay digested,	73.38
Grams pentosans digested,	47 01	Grams pentosans digested,	47.55
Per cent. pentosans digested,	61.70	Per cent. pentosans digested,	62.50
Average per cent. pentosans digested (two sheep),		62.10	

Period IX. — Winter Wheat Bran.

Sheep IV. Daily Statement. — Dry Matter.	Pentosans in Food consumed and Manure excreted.
517.38 grams hay consumed,	116.05
259.47 grams winter bran consumed,	63 90
Total consumed,	179 95
315.42 grams manure excreted,	64 50
Total digested,	115 45
Minus pentosans in hay digested,	74.61
Grams pentosans digested,	40.84
Per cent. pentosans digested,	63.90

Résumé of Results.

Comparison of the digestibility of the pentosans with the digestibility of the other fodder constituents: —

Kind of Food.	Dry Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).	Pentosans (Per Cent.).
Hay of mixed grasses (*a*),	61	64	51	63	63	63
Hay of mixed grasses (*b*),	56	57	47	57	58	62
Buffalo gluten feed, .	78	43	81	85	81	79
New-process linseed meal,	81	61	91	87	86	89
Old-process linseed meal,	79	57	89	89	78	85
Corn cobs, . . .	59	65	50	17	60	64
Dried brewers' grains, .	62	53	91	79	59	56
Spring wheat bran, .	63	24	76	80	70	62
Winter wheat bran, .	66	56	61	79	70	64

The above figures show that the pentosans in six out of nine cases are practically as digestible as any of the other groups of fodder substances.

In both samples of hay the pentosans are fully as digestible as either the cellulose or protein. In case of the dried brewers' grains and the two brans the fat and protein are noticeably more digestible than the pentosans.

With the more concentrated foods it will be observed that the pentosans are as digestible as either the fat, protein or extract matter. *The results make clear that association has a great deal to do with digestibility.* In the hays, corn cobs and brewers' grains, where the woody substance (lignin) is present to a considerable extent, the digestibility of the pentosans is noticeably less than when the incrusting substance is absent. Whether or not the pentosans are chemically united to the incrusting substances is not known, but it is not at all improbable. It is certainly clear that the in-

crusting substances perceptibly interfere with the digestibility of the xylan or araban. This has also been proved to be the case with cellulose, first indirectly by Henneberg and Stohmann * and later directly by F. Lehmann,† who found that when the fibre was freed from all incrusting substances the cellulose was practically all digestible.

Stone has already shown, in case of hays, bran and such fodders, that the pentosans have an average digestibility of 60 per cent., and our results with similar fodders simply confirm his investigations. With the more concentrated feeds, where little incrusting substance is present, the pentosans are as digestible as any other of the fodder groups. One might assume that if the pentosans were isolated and fed to animals they would be fully as digestible as starch or pure cellulose.

While from 60 to 90 per cent. of the pentosans in the present experiment have been removed from the digestive tract in the process of digestion, it has certainly not been demonstrated that they have been assimilated and have a food value equal to that of starch and similar substances. In case of human beings Ebstein has already proved to the contrary. We hope to be able to throw additional light upon this point in the near future.

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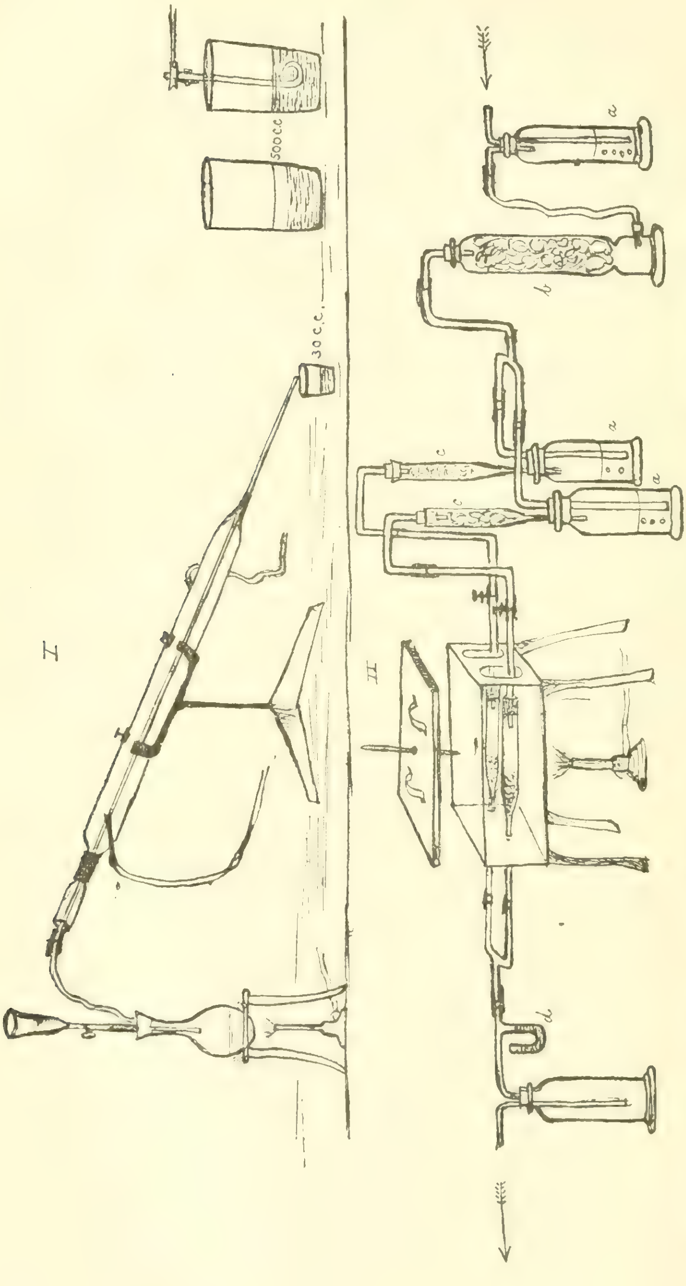
* Futterung der Wiederkauer, 1860.

† Journal f. Landw. **48**, 435.



I. Distillation Apparatus.
II. Drying Apparatus.
a. Sulphuric Acid.
b. Pumice Stone moistened with Sulphuric Acid.
c. Crushed Marble.
d. Filled with Mercury to show Vacuum.

PART II.

FIELD EXPERIMENTS.

C. A. Goessmann.

1. Field Experiments for the Purpose of studying the Economy of raising Leguminous Crops (Clover-like Plants) as a Means of enriching the Soil in Nitrogen in the Interest of the Subsequent Raising of Grain Crops (Field A).
2. Field Experiments with Several Prominent Varieties of Potatoes and Some Prominent Mixed Forage Crops (Vetch, Oats and Horse Bean, Vetch and Oats and Vetch and Barley) (Field B).
3. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops (Field C).
4. Experiments with Forage Crops (Field D), illustrated with Cuts of Roots of Four Prominent Leguminous Crops (Vetch, Soja Bean, Lupine and Horse Bean).
5. Trial of an Early Maturing Variety of Minnesota Dent Corn, Huron (Field E).
6. Field Experiments with Different Commercial Phosphates, to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates (Field F).
7. Experiments with Forage Crops (Vetch and Oats and Hungarian Grass) (Field G).
8. Field Experiments to study the Effect of Phosphatic Slag and Nitrate of Soda, as compared with Ground Bone, on the Yield of Oats and Corn (East Field).
9. Experiments with Permanent Grass Lands (Meadows) (East Field).
10. Orchard Experiments with Home-made Stable Manure, Unleached Wood Ashes and Several Mixtures of Fertilizing Materials on the Growth and Yield of Several Varieties of Fruit Trees.
11. Observations in Vegetation House.
12. Report on General Farm Work.

1. Field Experiments for the Purpose of studying the Economy of raising Leguminous Crops (Clovers, etc.) as a Means of enriching the Soil in Nitrogen in the Interest of the Subsequent raising of Grain Crops.

Field A.

The systematic treatment of the field here under consideration, as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883–84. The subdivision of the entire area into eleven plats (one-tenth of an acre each) of a uniform size and shape, one hundred and thirty-two feet long and thirty-three feet wide, with an unoccupied and unmanured space of five feet in width between adjoining plats, has been retained unaltered since 1884. A detailed statement of the particular aim and general management of our experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of our contemporary printed annual reports, to which I have to refer for details.

Since 1889 the main object of observations upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination, on the character and yield of the crop selected for the trial.

Several plats which for five preceding years did not receive any nitrogen compound for manurial purposes were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation, while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years; namely, either as sodium nitrate or as ammonium sulphate, or as organic nitrogenous matter in form of dried blood or of barn-yard manure. A corresponding amount of available nitrogen was applied in all these cases.

Amount of Fertilizing Ingredients used Annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen, ...	45 pounds.
	Phosphoric acid, . . .	80 pounds.
	Potassium oxide, . . .	125 pounds.
Plats 4, 7, 9, ...	Nitrogen, ...	none.
	Phosphoric acid, . . .	80 pounds.
	Potassium oxide, . . .	125 pounds.

One plat, marked 0, received its main supply of phosphoric acid, potassium oxide and nitrogen in form of barn-yard manure; the latter was carefully analyzed before being applied, to determine the amount required to secure, as far as practicable, the desired corresponding proportion of the three essential fertilizing constituents. The deficiency in potassium oxide and phosphoric acid was supplied by potash-magnesia sulphate and dissolved bone-black. The fertilizer for this plat consisted of 800 pounds of barn-yard manure, 32 pounds of potash-magnesia sulphate and 18 pounds of dissolved bone-black.

The mechanical preparation of the soil, the incorporation of the manurial substances, — the general character of the latter being the same, — the seeding, cultivating and harvesting were carried on year after year in a like manner and as far as practicable on the same day in case of every plat during the same year.

The subsequent tabular statement shows the annual application and special distribution of the manurial substances with reference to each plat since 1889. The fertilizers were in every case applied broadcast as early in the spring as circumstances permitted. They were well harrowed under before the seed was planted in rows by a seed drill.

Plats.	Annual Supply of Manurial Substances.
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Cost of Fertilizers applied to Field A.

	Cost per Plat.	Cost per Acre.
Plat 0, ...	$2 28	$22 75
Plat 1, ...	1 99	19 90
Plat 2, ...	2 43	24 30
Plat 3, ...	2 09	20 90
Plat 4, ...	1 23	12 30
Plat 5, ...	2 46	24 58
Plat 6, ...	2 02	20 18
Plat 7, ...	1 23	12 30
Plat 8, ...	2 02	20 18
Plat 9, ...	1 23	12 30
Plat 10, ...	2 53	25 30

The above-described course of the general management of the experiment has been followed thus far for five consecutive years (1889–93, inclusive).

Kind of Crops raised.

Corn (maize), ...	in 1889.
Oats, ...	in 1890.
Rye, ...	in 1891.
Soja bean, ...	in 1892
Oats, ...	in 1893.

The annual yield of the various crops upon the different plats showed that as a rule those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that received annually in some form or other an addition of a corresponding amount of available nitrogen.

The results of our observations were stated as follows: —

The experiments carried on upon Field A during the years 1889, '90, '91 and '92 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen, to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soja bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892).

1893. — The main object of our experiment upon Field A during that season was to observe the after-effect of the cultivation of soja bean (a leguminous crop) on the nitrogen resources of the soil which served for its production. It seemed of interest in our case to ascertain whether the raising of the soja bean upon Field A had increased the amount of available nitrogen stored up in the soil to such an extent as to affect the yield of the succeeding crop upon those plats (4, 7, 9) which as a rule did not receive at any time an addition of available nitrogen from any other manurial source but the atmospheric air and the roots of the soja beans left in the soil after harvesting the crop.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in preceding years (see tenth annual report).

Yield of Oat Crop on Different Plats (1893).

[Pounds.]

	Weight of Oats.	Weight of Oats per Acre.	Weight of Straw and Chaff.	Weight of Grain.	Weight of Straw and Chaff per Acre.	Weight of Grain per Acre.
Plat 0, . . .	530	5,300	399	131	3,990	1,310
Plat 1, . . .	690	6,900	555	135	5,550	1,350
Plat 2, . . .	600	6,000	454	146	4,540	1,460
Plat 3, . . .	700	7,000	534	166	5,340	1,660
Plat 4, . . .	590	5,900	430	160	4,300	1,600
Plat 5, . . .	630	6,300	551	79	5,510	790
Plat 6, . . .	600	6,000	498	102	4,980	1,020
Plat 7, . . .	550	5,500	431	119	4,310	1,190
Plat 8, . . .	420	4,200	325	95	3,250	950
Plat 9, . . .	480	4,800	370	110	3,700	1,100
Plat 10, . . .	610	6,100	485	125	4,850	1,250

Ratio of Grain to Straw.

Plat 0, ...	1:3	Plat 6, ...	1:4.9
Plat 1, ...	1:4.1	Plat 7, ...	1:3.6
Plat 2, ...	1:3.1	Plat 8, ...	1:3.4
Plat 3, ...	1:3.2	Plat 9, ...	1:3.4
Plat 4, ...	1:2.7	Plat 10, ...	1:3.9
Plat 5, ...	1:7		

Conclusions. — An examination of the results given above shows that the total crop per acre on those plats to which no nitrogen was applied (4, 7 and 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other.

Plat 8 shows again the exceptional conditions of previous years, for, although fertilized in a like manner as Plat 6, its total yield was 1,800 pounds less.

In yield of grain those plats which received their nitrogen in the form of sulphate of ammonia (5, 6 and 8) averaged 92 pounds; those in the form of organic nitrogen (0, 6 and 8), 140⅔ pounds; those in the form of nitrate of soda (1 and 2), 140½ pounds.

The best results in relation of total yield to yield of grain were obtained in the case of those plats receiving organic nitrogen (dried blood and barn-yard manure), or nitrogen in the form of nitrate of soda; while in the case of sulphate of ammonia the ratio of grain to straw was too wide to give the best satisfaction.

The total yield of crops on the plats receiving no nitrogen addition, as compared with those receiving a nitrogen supply, was during the succeeding years as follows: —

With oats in 1890, one-fifth to one-sixth less;
With rye in 1891, one-fifth to one-sixth less;
With soja bean in 1892, one-third to one-fourth less; and
With oats in 1893, one-seventh to one-eighth less.

From this it will appear that the introduction of a leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it.

It was decided to continue the observation by repeating the raising of soja beans in 1894 and oats in 1895.

1894. — To secure, if possible, more decisive results regarding the presence and absence of nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

Plats.	Manurial Substances Applied.
Plat 0, .	800 lbs. barn-yard manure, 80½ lbs. potash-magnesia sulphate and 77 lbs. dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 2, .	29 lbs. nitrate of soda (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 3, .	43 pounds dried blood (= 5 to 6 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 4, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 5, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 97 lbs. potash-magnesia sulphate (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 6, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 7, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 8, .	22½ lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 9, .	54 lbs. muriate of potash (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 4 to 5 lbs. nitrogen), 97 lbs. sulphate of potash-magnesia (= 25 to 26 lbs. potassium oxide), and 114 lbs. dissolved bone-black (= 16 to 17 lbs. phosphoric acid).

An early maturing variety of white soja bean was the crop employed for the experiment. The field was ploughed April 18, the barn-yard manure having been previously applied to Plat 0, and a quantity of lime to Plat 8.* Plats 1–10 received their fertilizer mixtures applied broadcast on May 10. After proper preparation of the soil the soja beans were planted on May 12 in drills two and one-half feet apart, six pounds of seed being used per plat. The plants appeared above ground May 21. June 5 the field was cultivated and hoed, and also on the 16th and 25th and July 12.

* This plat had suffered for years, as noted in previous reports, from a serious attack of parasitic growth affecting the yield of the crop, and the lime was added to correct the condition of the soil and prevent, if possible, the return of the failure. The purpose for which it was applied was evidently served, for the yield of the crop was very satisfactory.

Height of Soja-bean Plants upon the Different Plats of Field A during the Season (1894).

[Inches.]

	July 3.	July 10.	July 24.
Plat 0,	12	16	24
Plat 1,	12	16	25
Plat 2,	12	19	26
Plat 3,	11	15	26
Plat 4,	11	14	25
Plat 5,	13	17	25
Plat 6,	11	16	26
Plat 7,	10	14	24
Plat 8,	12	15	27
Plat 9,	10	14	25
Plat 10,	11	16	26

The color of the crop varied somewhat on the different plats. Those receiving no nitrogen addition had a yellowish appearance throughout the season, while No. 8, which in previous years had been of inferior growth and color, appeared to do as well as any during the entire growing period. The plants began to bloom July 25. Owing to the protracted drought of July and August the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28, being put into a silo with corn for the production of a mixed silage.

Yield of Soja Bean on Different Plats (1894).

[Pounds.]

	Per Plat.	Per Acre.
Plat 0,	600	6,000
Plat 1,	625	6,250
Plat 2,	700	7,000
Plat 3,	525	5,250
Plat 4,	405	4,050
Plat 5,	645	6,450
Plat 6,	615	6,150
Plat 7,	480	4,800
Plat 8,	680	6,800
Plat 9,	470	4,700
Plat 10,	570	5,700

Conclusions.

1. A comparison of the above-stated yield of the different plats shows that those plats (4, 7 and 9) which received no nitrogen addition from an outside source yielded on an average from 1,400 to 1,500 pounds less per acre than those receiving a nitrogen addition.

2. From these figures it appears that the increased cost of the fertilizer in the case of the plats receiving nitrogen (45 pounds nitrogen at 13 cents = \$6.75) exceeds the value of the increase in crop produced by its application (allowing \$5 per ton of green material containing 34.02 per cent. dry matter).

3. An increase of twice the amount of the phosphoric acid and potassium oxide as compared with earlier years (see report for 1892) has not affected the relative yield of the crop.

Analysis of Early Maturing Soja Bean.

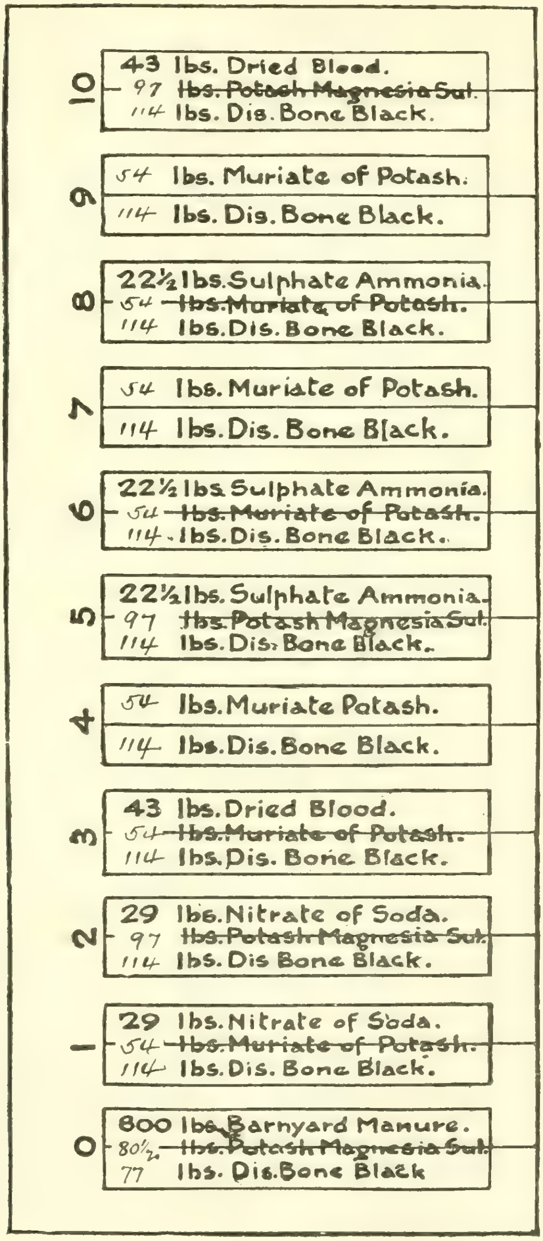
[Raised on Field A; collected when crop was cut, Aug. 28, 1894.]

	Per Cent.
Moisture at 100° C.,	65.98
Dry matter,	34.02
	100.00

Analysis of Dry Matter.

Crude ash,	9.69
" fibre,	17.28
" fat,	2.96
" protein,	20.13
Nitrogen-free extract matter,	49.94
	100.00

Field "A," 1894.



SCALE, 4 RODS TO 1 INCH.

2. Field Experiments with Several Varieties of Potatoes and Some Prominent Mixed Forage Crops.

Field B.

[*a.* Potatoes: Beauty of Hebron, Clark's and New Queen; *b.* Mixed forage crops: vetch, oats and horse bean, vetch and oats and vetch and barley.]

This field occupies an area of one and seven-tenths acres, and runs from north to south, nearly on a level. The soil consists of a somewhat sandy loam of several feet in depth. The systematic treatment of the area was inaugurated in 1884, when the present subdivision into eleven plats was first introduced. The plats are 175 feet long and 33 feet wide (5,775 square feet, or two-fifteenths of an acre), of a uniform shape, running from east to west, with a space of five feet between adjoining plats. The numbering begins at the north end with 11, and closes at the south end with 21.

For details regarding the work carried on upon Field B previous to 1892, see tenth annual report.

The character of the crops raised during 1892 may be noticed from the subsequent tabular statement: —

Crops raised in 1892.

Plats.	1892.	Yield of Hay, First and Second Cut (Pounds).	Rate per Acre (Pounds).
Plat 11,	Kentucky blue-grass, sown Sept. 24, 1889,	335	2,513
Plat 12,	Kentucky blue-grass and red-top, sown Sept. 18, 1891,	365	2,737
Plat 13,	English rye-grass and Italian rye-grass, sown Sept. 29, 1890.	255	1,913
Plat 14,	English rye-grass and red top, sown Sept. 29, 1890,	225	1,688
Plat 15,	Herds grass and red top, sown April 23, 1891,	565	4,238
Plat 16,	Italian rye-grass and red top, sown April 23, 1891,	565	4,238
Plat 17,	Meadow fescue, sown Sept. 25, 1887,	475	3,563
Plat 18,	Meadow fescue, sown Sept. 29, 1890,	490	3,675
Plat 19,	Herds grass, sown Sept. 25, 1889,	610	4,575
Plat 20,	Herds grass and red top, sown Sept. 29, 1890,	285	2,138
Plat 21,	Meadow fescue and herds grass, sown Sept. 18, 1891,	355	2,663
	Total,	4,525	-

At the close of the season (1892) it was decided to raise hereafter other crops than grasses upon plats 11, 13, 14, 15, 16 and 20. For this reason they were ploughed after the rowen had been secured, while plats 12, 17, 18, 19 and 21 remained in grass for another season.

1893. — Plats 11, 13, 14, 15, 16 and 20, which had been used for several preceding years for the production of grasses, were at an early date prepared to serve for experiments with several prominent varieties of potatoes. They were ploughed in August, 1892, and were again ploughed for the final preparation April 25, 1893.

It was proposed to compare the yield, as far as quantity and quality are concerned, under otherwise corresponding circumstances. Three varieties of potatoes, Beauty of Hebron, Clark's, New Queen, were chosen for the trial. The seed potatoes were obtained of J. J. H. Gregory & Son, Marblehead.

Two plats, 15 and 16, were assigned for the cultivation of Beauty of Hebron; two, 13 and 14, for that of New Queen; and two, 11 and 20, for that of Clark's variety.

One plat in each case received its potash supply in form of muriate of potash (plats 11, 13 and 15), and one in each case in that of high-grade sulphate of potash (plats 14, 16, 20). The actual amount of potassium oxide used in all cases remained the same.

Statement of Fertilizers used (*Pounds*).

		Per Plat.	Per Acre.
Plats 11, 13, 15,	Muriate of potash,	54	400
	Bone,	80	600
Plats 14, 16, 20,	Sulphate of potash (high grade),	54	400
	Bone,	80	600

Composition of Fertilizers used.

[Per Cent.]

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone,	4.02	–	22.96
Sulphate of potash,	–	50.20	–
Muriate of potash,	–	46.00	–

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 11, 13, 15,	$2 39	$17 93
Plats 14, 16, 20,	2 66	19 95

The final mechanical preparation of the different plats was the same in all cases. The fertilizer was applied broadcast, and subsequently thoroughly harrowed in before planting. The potatoes were planted May 10 on all plats at the rate of nineteen bushels per acre, or two and one-half bushels potatoes per plat. Potatoes used were either whole ones of medium size, or when larger were cut in pieces of sizes corresponding to the former. Plats 11 and 20 were planted with Clark's variety; plats 13 and 14 were planted with New Queen variety; plats 15 and 16 were planted with Beauty of Hebron variety.

The crop began to break ground May 26, and was subsequently cultivated and hoed June 5 and June 20. The potatoes were in bloom June 24, and the tops began to die August 14. The crop was harvested August 23 and 24.

The potatoes were in all cases of a superior appearance; only one-eighth to one-ninth of the entire crop was not marketable as a first-class article, on account of small size.

Yield of Crop.

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

Variety.	Amount per Plat.			Rate per Acre.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 11, Clark's, . .	1,450	225	1,675	10,875	1,688	12,563
Plat 13, New Queen, . .	1,620	240	1,860	12,150	1,800	13,950
Plat 15, Beauty of Hebron,	2,160	190	2,350	16,200	1,425	17,625

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 11, Clark's, . .	–	–	–	181	28	209
Plat 13, New Queen, . .	–	–	–	203	30	233
Plat 15, Beauty of Hebron,	–	–	–	270	24	294

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

Variety.	Amount per Plat.			Rate per Acre.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . .	1,540	230	1,770	11,550	1,725	13,275
Plat 14, New Queen, . .	1,860	190	2,050	13,950	1,425	15,375
Plat 16, Beauty of Hebron,	2,190	240	2,430	16,425	1,800	18,225

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . .	–	–	–	193	29	222
Plat 14, New Queen, . .	–	–	–	233	24	257
Plat 16, Beauty of Hebron,	–	–	–	274	30	304

From an examination of the above tabular statement of the yield of the different varieties of potatoes on trial we arrived at the following conclusions : —

1. The yield of potatoes is in every instance larger in case sulphate of potash has furnished the potash of the fertilizer used than where muriate of potash has served for that purpose.

2. The yield of the three varieties of potatoes on trial, although raised under a corresponding system of cultivation and of manuring, differs seriously. Beauty of Hebron produces nearly one-sixth more in weight than the New Queen variety, and one-third more than the Clark variety.

Plats 12, 17, 18, 19 and 21, which remained in grass in previous years, received as top-dressing, muriate of potash, 200 pounds, and ground bone, 600 pounds, per acre, at an early date in the spring, 1893. The grass was cut June 27 and 28. As the weeds began to infest the plats, the experiment of studying a variety of grasses was closed, and the sod turned under during the month of August. Dry lands do not favor for any length of time an economical and clean cultivation of the majority of our best grasses. For details, see eleventh annual report for 1893.

A. *Observations with Potatoes (1894).*

During the present season the experiments of the preceding year with potatoes were repeated, and several varieties of mixed forage crops substituted for the grasses. Beauty of Hebron, Clark's and New Queen were the varieties of potatoes used in the trial, the seed tubers being selected from our crop of the previous year. Beauty of Hebron were grown on plats 12 and 21, New Queen on 17 and 18, and Clark's on 19 and 20. One plat in each case was supplied with potash in the form of muriate of potash (17, 19 and 21), and one in each case in the form of high-grade sulphate of potash (12, 18 and 20).

Fertilizer used.

[Pounds.]

		Per Plat.	Per Acre.
Plats 12, 18, 20,	Sulphate of potash (high grade), .	54	400
	Bone, ...	80	600
Plats 17, 19, 21,	Muriate of potash, ...	54	400
	Bone, ...	80	600

Composition of Fertilizer used.

	Nitrogen.	Potash.	Phosphoric Acid.
Fine-ground bone, ...	4.09	–	21.86
Sulphate of potash, ...	–	50.80	–
Muriate of potash, ...	–	52.20	–

Market Cost of Fertilizers.

	Per Plat.	Per Acre.
Plats 12, 18, 20, ...	$2 39	$17 80
Plats 17, 19, 21, ...	2 12	15 80

The field was ploughed April 11, the fertilizer was applied broadcast April 20, and harrowed in. The potatoes were planted April 24, at the rate of two and one-half bushels per plat, or nineteen bushels per acre. As far as possible medium-sized whole potatoes were used for seed, and when larger ones were used they were cut in pieces corresponding in size to the former. May 11 the crop began to appear above ground, but was somewhat nipped by the frost of the 15th. The field was cultivated and hoed May 30 and June 18, on which latter date the first appearance of blooming was noticed on the various plats, Beauty of Hebron leading. Owing to the severe drought during the latter part of the

growing period, the crop did not turn out as good as at first indicated, there being a serious falling off in yield and an unusually large proportion of small tubers.

YIELD OF CROP (1894).

A. Potash applied in the Form of Muriate.

Yield of Potatoes in Pounds.

VARIETY.	Amount per Plat.			Rate per Acre.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 19, Clark's, . . .	870	539	1,409	6,660	4,064	10,724
Plat 17, New Queen, . .	1,161	563	1,724	8,754	4,245	12,999
Plat 21, Beauty of Hebron, .	962	449	1,411	7,253	3,384	10,637

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 19, Clark's, . . .	–	–	–	111	67	178
Plat 17, New Queen, . .	–	–	–	146	70	216
Plat 21, Beauty of Hebron, .	–	–	–	121	56	177

B. Potash applied in the Form of High-grade Sulphate.

Yield of Potatoes in Pounds.

VARIETY.	Amount per Plat.			Rate per Acre.		
	Marketable.	Small.	Total.	Marketable.	Small.	Total.
Plat 20, Clark's, . . .	741	527	1,268	5,587	3,973	9,560
Plat 18, New Queen, . .	1,183	510	1,693	8,920	3,845	12,765
Plat 12, Beauty of Hebron, .	1,230	511	1,741	9,274	3,853	13,127

Yield of Potatoes in Bushels (60 Pounds per Bushel).

Plat 20, Clark's, . . .	–	–	–	93	66	159
Plat 18, New Queen, . .	–	–	–	149	64	213
Plat 12, Beauty of Hebron, .	–	–	–	154	64	218

Comparison of Yield for 1893 and 1894.

Total Yield (Bushels per Acre).

	1893.	1894.	Percentage of Decrease.
Clark's, with muriate of potash, . .	209	178	14.84
New Queen, with muriate of potash, .	233	216	7.30
Beauty of Hebron, with muriate of potash,	294	177	19.80
Clark's, with sulphate of potash, . .	222	159	28.38
New Queen, with sulphate of potash, .	257	213	17.12
Beauty of Hebron, with sulphate of potash,	304	218	27.60

Percentage of Marketable Potatoes.

Clark's, with muriate of potash, . .	86.60	62.36	24.24
New Queen, with muriate of potash, .	87.12	67.59	19.53
Beauty of Hebron, with muriate of potash,	91.83	68.36	23.47
Clark's, with sulphate of potash, . .	86.92	58.49	28.43
New Queen, with sulphate of potash, .	90.66	70.00	20.66
Beauty of Hebron, with sulphate of potash,	90.13	70.64	19.49

The crop of 1894 as compared with that of 1893 is in every case smaller, owing to the exceptionally dry season.

The relative proportion of marketable tubers is considerably greater in 1893 than in 1894, owing to a premature cessation of growth during the drought.

The difference in yield of the plats receiving muriate, as compared with those receiving high-grade sulphate of potash, is but slight.

The severe drought has affected results to such an extent that no further conclusions can be drawn with reference to the fertilizer used.

B. Observations with Mixed Forage Crops (1894).

Plats 11, 13, 14, 15 and 16, which were used for the production of potatoes during 1893, were set apart for the raising of mixed forage crops during 1894. Plats 11, 13 and 15 were fertilized at the rate of 400 pounds of muriate of potash and 600 pounds of ground bone per acre, while plats 14 and 16 were fertilized with 400 pounds of high-grade sulphate of potash and 600 pounds ground bone. Vetch, oats and horse bean were raised on Plat 11, vetch and barley on plats 13 and 14 and vetch and oats on plats 15 and 16. The plats were prepared for planting at the same time and in a similar manner as those used for the raising of potatoes.

Vetch and Barley. — Plats 13 and 14 were prepared for the raising of vetch and barley. Plat 13 was fertilized with muriate of potash and bone and Plat 14 with sulphate of potash and bone. The seed was sown April 26, at the rate of 45 pounds vetch and 3 bushels barley per acre. The plants appeared above ground May 4.

Height of Plants on Plats.

[Inches.]

	Plat 13 (Muriate).	Plat 14 (Sulphate).
June 12, ...	20	20
June 18, ...	28	28

The barley began to head out June 20, and June 23 the crop was cut for hay, the vetch being just in bloom. The yield of hay was as follows : —

	Per Plat (Pounds).	Per Acre (Pounds).
Plat 13, ...	765	5,737
Plat 14, ...	677	5,077

Analyses of Vetch and Barley.

[Equal number of plants of each; collected June 22, 1894.]

	Per Cent.	
	Plat 13.	Plat 14.
Moisture at 100° C.,	78.23	77.70
Dry matter,	21.77	22.30
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.64	7.80
" fibre,	32.25	32.58
" fat,	2.12	2.56
" protein,	14.44	13.36
Nitrogen-free extract matter,	46.55	43.70
	100.00	100.00

Vetch and Oats. — Plats 15 and 16 were set aside for the raising of vetch and oats. Plat 15 was fertilized with 400 pounds muriate of potash and 600 pounds ground bone per acre, and Plat 16 with 400 pounds of high-grade sulphate of potash and 600 pounds ground bone. The land was prepared as for the other plats. The seed was put in April 6, at the rate of 45 pounds vetch and 4 bushels of oats per acre. May 4 the plants appeared above ground.

Height of Plants on Plats.

[Inches.]

	Plat 15 (Muriate).	Plat 16 (Sulphate).
June 12,	20	20
June 18,	26	24
June 26,	33	33

The oats began to head out June 25, and the crop was cut for hay July 2, the vetch being then on the point of blooming. The yield of hay was as follows: —

	Pounds.	
	Per Plat.	Per Acre.
Plat 15,	1,068	8,051
Plat 16,	940	7,088

Analyses of Vetch and Oats.

[Equal number of plants of each; collected July 5, 1894.]

	Per Cent.	
	Plat 15.	Plat 16.
Moisture at 100° C.,	76.24	75.29
Dry matter,	23.76	24.71
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.59	8.69
" fibre,	29.83	31.28
" fat,	3.13	2.63
" protein,	18.88	15.16
Nitrogen-free extract matter,	38.57	42.24
	100.00	100.00

Vetch, Oats and Horse Bean. — Plat 11, which was used for growing the above crop, was fertilized at the rate of 400 pounds of muriate of potash and 600 pounds of ground bone per acre, the preparation of the plat for the seed being the same as for the other plats. May 8 the seed was sown, at the rate of 60 pounds vetch, 60 pounds horse bean and 136 pounds of oats per acre. On May 16 the vetch and oat plants were coming up, and the horse bean appeared on the 21st.

Height of Plants.

[Inches.]

June 18,	15
June 26,	22

June 28 the horse-bean plants began to bloom, and July 2 the crop was cut. The plat yielded 835 pounds of hay, at the rate of 6,294 pounds per acre.

Analysis of Vetch, Oats and Horse Bean.

[Three plants each of vetch and of oats and one of horse bean; collected July 9, 1894.]

	Per Cent.
Moisture at 100° C.,	82.13
Dry matter,	17.87
	100.00

Analysis of Dry Matter.

Crude ash,	10.36
" fibre,	30.07
" fat,	2.70
" protein,	18.93
Nitrogen-free extract matter,	77.94
	100.00

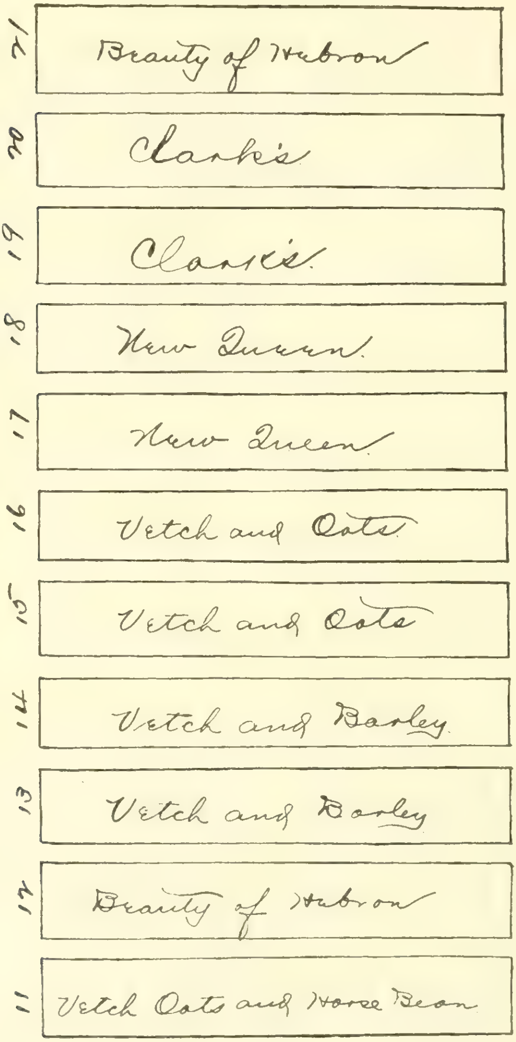
Conclusions.

On the whole, vetch and oats leads vetch and barley, on account of the larger and more foliaceous character of the oats as compared with the barley. Vetch, oats and horse bean leads in nitrogenous matter, and no doubt will exceed in regard to the nutritious character of the crop as soon as the amount of horse bean has been doubled, as indicated above. (Every one of these crops compares well with clover hay.)

The large yield of these crops per acre, their high nutritive value and special adaptation for green fodder, hay or ensilage, merit serious attention for the support of farm and dairy stock.

The early date of maturity presents exceptionally good chances of raising a second crop for fall supply, or for a timely preparation of the soil for winter crops.

Field "B," 1894.



Scale, 4 rods to 1 inch.

3. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

Field C.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size ($89\frac{1}{2}$ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of five feet of unmanured and unseeded yet cultivated land. They are arranged in two parallel rows, running from west to east. Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration.

The entire field occupied by the experiment is nearly on a level. Its earlier history can be learned from previous annual reports.

The observation with raising garden crops, by the aid of different mixtures of commercial manurial substances here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats Nos. 1, 2 and 3 during that of 1892. The difference of the fertilizers applied consisted in the circumstance that different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid addition in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in the form of organic animal matter, dried blood; others in the form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received

their potash in the form of muriate of potash and others in the form of the highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of the manurial substances applied to the different plats: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

Beets, cabbages, celery, lettuce, spinach, tomatoes and potatoes have thus far been raised upon the field.

The order of arrangement of the different crops within each plat was the same in all of them for the same year. They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops.

Order of arrangement of crops in plats : —

1892.	1893.	1894.
Celery.	Spinach.	Potatoes.
Lettuce.	Celery.	Beans.
Spinach.	Lettuce.	Tomatoes.
Beets.	Red Cabbage.	Spinach.
Cabbages.	Beets.	Lettuce.
Tomatoes.	Potatoes.	Onions.
Potatoes.	Beets.	
	White Cabbage.	
	Tomatoes.	

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three above-stated essential ingredients of plant food : —

Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food : —

4.1 pounds of nitrogen.
3.9 pounds of potassium oxide.
1.9 pounds of phosphoric acid.

The weights and particular stage of growth of the vegetables when harvested control under otherwise corresponding conditions the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty

one, especially in the case of those crops which reach in a short period the desired state of maturity.

The various mixtures of fertilizers used by us in the experiments under discussion provide by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil.

1894. — The field was ploughed April 22, and the fertilizer mixtures previously given were applied broadcast the 23d and thoroughly harrowed in. Potatoes, beans, tomatoes, spinach, lettuce and onions were the crops selected for trial in each plat, being arranged as follows, beginning at the west side of each plat: —

Five rows of potatoes (Beauty of Hebron).
Six rows of beans.
Two rows of tomatoes (Essex Hybrid).
Two rows of spinach (New Zealand).
One row of lettuce (Hanson).
Four rows of onions (Yellow Globe Danvers).

Lettuce and tomato plants were raised in the hot-bed and subsequently transferred to the plats. The work of seed sowing and transplanting was done for each particular kind on the same day. April 25 the potatoes were planted, one bushel of seed being used per plat; the spinach and onion seed were put in April 26; the beans on May 7; May 18 the lettuce plants were set out from the hot-bed, and the tomato plants on May 19. The onion plants began to appear May 7; the spinach plants May 9; the potatoes appeared on the 11th, being touched by the frost of the 15th; the beans began to appear May 17, but owing to poor germination on plats 2, 3, 5 and 6 additional seed was put in about the last of May. All crops were kept free from weeds and treated similarly throughout the season. The various crops were harvested whenever fit for the market. A severe drought during the months of July and August affected seriously the yield of crops and the time of harvesting. The subsequent statements give data regarding date of maturity and yield of the different crops.

Yield of Spinach (Variety New Zealand).

Plats.	Pounds.
Plat 1 (two rows),	101
Plat 2 (two rows),	216
Plat 3 (two rows),	165
Plat 4 (two rows),	$161\frac{3}{4}$
Plat 5 (two rows),	253
Plat 6 (two rows),	$113\frac{3}{4}$

The seed was sown April 26; the crop was harvested July 2.

Yield of Lettuce (Variety Hanson).

Plats.	Perfect Heads.	Pounds.
Plat 1 (one row; eighty-one plants),	45	$33\frac{1}{4}$
Plat 2 (one row; one hundred and two plants),	97	$76\frac{3}{4}$
Plat 3 (one row; one hundred and six plants),	81	$54\frac{1}{2}$
Plat 4 (one row; one hundred and two plants),	95	$74\frac{1}{2}$
Plat 5 (one row; one hundred and six plants),	104	$98\frac{1}{2}$
Plat 6 (one row; ninety-two plants),	71	43

The plants were set out May 17; they were harvested June 29.

Yield of Potatoes (Variety Beauty of Hebron).

Plats.	Pounds.		
	Marketable.	Small.	Total.
Plat 1 (five rows), ...	205	115	320
Plat 2 (five rows), ...	240	175	415
Plat 3 (five rows), ...	220	150	370
Plat 4 (five rows), ...	220	170	395
Plat 5 (five rows), ...	195	195	390
Plat 6 (five rows), ...	240	155	395

The potatoes were planted April 25; they were harvested August 7.

Yield of Beans.

Plats.	Pounds.
Plat 1 (six rows), ...	45
Plat 2 (six rows), ...	32
Plat 3 (six rows), ...	41
Plat 4 (six rows), ...	20
Plat 5 (six rows), ...	37
Plat 6 (six rows), ...	49

The beans were planted May 7. The germination on plats 2, 3, 5 and 6 was very imperfect, and May 27 extra seed was put in on these plats. June 25 first of plants came into bloom; they were threshed August 17.

Yield of Onions (Variety Yellow Globe Danvers).

Plats.	Pounds.
Plat 1 (four rows), ...	156
Plat 2 (four rows), ...	249
Plat 3 (four rows), ...	251
Plat 4 (four rows), ...	256
Plat 5 (four rows), ...	266
Plat 6 (four rows), ...	204

The seed was sown April 26; the crop was harvested September 24.

Yield of Tomatoes (Variety Essex Hybrid).

Date of Harvesting.	Pounds.					
	1.	2.	3.	4.	5.	6.
August 10 (matured), . .	–	3	10	9	7	8
August 14 (matured), . .	8	25	12	13	12	12
August 17 (matured), . .	29	77	40	52	60	31
August 20 (matured), . .	38	71	82	81	79	69
August 23 (matured), . .	22	43½	47	41½	48	38
August 27 (matured), . .	56	77	61	93	74	69
August 31 (matured), . .	54	70	56	92	76	66
September 4 (matured), .	31	45	40	46	50	56
September 10 (matured), .	60	68	54	85	112	66
Total weight of matured tomatoes, . . .	298	489	402	512	518	415
September 11 (green), . .	54	70	56	92	76	56
Total weight of green and matured, ...	352	559	458	604½	594	571

There were two rows of tomatoes in each plat, with 22 plants in each row. They were set out May 19 and began to bloom June 5.

Potatoes (*Variety Beauty of Hebron*).

Plats.	Pounds.			
	1891.	1892.	1893.	1894.
Plat 1 (five rows), ...	–	585	400	320
Plat 2 (five rows), ...	–	665	520	415
Plat 3 (five rows), ...	–	545	390	370
Plat 4 (five rows), ...	735	640	525	395
Plat 5 (five rows), ...	780	740	520	390
Plat 6 (five rows), ...	–	435	580	395

Tomatoes (*Variety Essex Hybrid*).

Plats.	Pounds.			
	1891.	1892.	1893.	1894.
Plat 1 (two rows), ...	–	464	363	352
Plat 2 (two rows), ...	–	572	874½	559
Plat 3 (two rows), ...	–	466	807	458
Plat 4 (two rows), ...	641	515	818	604
Plat 5 (two rows), ...	647	593	978½	594
Plat 6 (two rows), ...	–	332	515	571

Lettuce (Variety Hanson).

Seventy Plants.	1892.	1893.	1894.
Plat 1 (one row),	41½	40½	29
Plat 2 (one row),	36	42	52
Plat 3 (one row),	43	46	36
Plat 4 (one row),	76	62	50
Plat 5 (one row),	60	70	68
Plat 6 (one row),	36	55	33

Spinach (Variety New Zealand).

Plats.	1892.	1893.	1894.
Plat 1 (two rows),	192	167½	101
Plat 2 (two rows),	233	182	216
Plat 3 (two rows),	202	180½	165
Plat 4 (two rows),	230	–	161¾
Plat 5 (two rows),	232	210	253
Plat 6 (two rows),	134	198½	113¾

From our observations as above reported, extending over three years, we may draw the following conclusions: —

Potash in the form of sulphate has given the most satisfactory results, as compared with muriate, in the case of potatoes, tomatoes, lettuce and spinach, and with onions during the present season.

Nitrogen in the form of nitrate of soda has given us, without regard to the potash source, the most satisfactory returns in case of spinach, lettuce, potatoes and tomatoes, and with onions during the present season.

Lettuce (sampled July 6, 1893).

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	96.93	96.97
Dry matter,	3.07	3.03
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	17.84	15.66
" fibre,	13.35	14.11
" fat,	3.36	3.44
" protein,	23.83	26.85
Nitrogen-free extract matter,	41.62	39.94
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	96.930	96.970
Calcium oxide,	.026	.026
Magnesium oxide,	.005	.003
Sodium oxide,	.015	.018
Potassium oxide,	.241	.233
Phosphoric acid,	.017	.036
Nitrogen,	.117	.130
Insoluble matter,	.124	.104

Spinach (sampled July 12, 1893).

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	92.80	91.63
Dry matter,	7.20	8.37
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	29.47	29.06
" fibre,	12.49	11.77
" fat,	2.42	2.12
" protein,	25.45	28.53
Nitrogen-free extract matter,	30.17	28.52
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	92.800	91.630
Calcium oxide,	.054	.065
Magnesium oxide,	.049	.052
Sodium oxide,	.199	.230
Potassium oxide,	.838	1.076
Phosphoric acid,	.046	.055
Nitrogen,	.293	.382
Insoluble matter,	.273	.272

Beets.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	79.54	82.91
Dry matter,	20.46	17.09
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	5.46	5.72
" fibre,	5.68	5.88
" fat,	.33	.36
" protein,	14.56	13.59
Nitrogen-free extract matter,	73.97	74.45
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	79.540	82.910
Calcium oxide,	.143	.077
Magnesium oxide,	.031	.025
Sodium oxide,	.098	.125
Potassium oxide,	.524	.450
Phosphoric acid,	.136	.113
Nitrogen,	.476	.368
Insoluble matter,	.109	.106

Cabbage.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	92.95	93.74
Dry matter	7.05	6.26
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	9.76	6.80
" fibre,	15.69	14.57
" fat,	1.95	2.46
" protein,	3.16	3.85
Nitrogen-free extract matter,	69.44	72.32
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	92.950	93.740
Calcium oxide,	.026	.024
Magnesium oxide,	.010	.010
Sodium oxide,	.040	.029
Potassium oxide,	.363	.299
Phosphoric acid,	.017	.036
Nitrogen,	.223	.241
Insoluble matter,	.217	.165

Tomatoes.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	93.51	94.44
Dry matter,	6.49	5.56
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.99	7.18
" fibre,	9.71	9.40
" fat,	4.96	4.95
" protein,	16.57	20.85
Nitrogen-free extract matter,	60.77	57.62
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	93.510	94.440
Calcium oxide,	.030	.024
Magnesium oxide,	.019	.014
Sodium oxide,	–*	–*
Potassium oxide,	.353	.356
Phosphoric acid,	.045	.039
Nitrogen,	.170	.185
Insoluble matter,	.011	.021

* Not determined.

Potatoes.

	Plat 1 (Per Cent.).	Plat 4 (Per Cent.).
Moisture at 100° C.,	80.71	81.17
Dry matter,	19.29	18.83
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	4.71	4.64
" fibre,	2.26	2.35
" fat,	.54	.42
" protein,	10.98	10.06
Nitrogen-free extract matter,	81.51	82.53
	100.00	100.00

Fertilizing Constituents.

Moisture at 100° C.,	80.710	81.170
Calcium oxide,	.018	.020
Magnesium oxide,	.044	.041
Sodium oxide,	.029	.024
Potassium oxide,	.607	.553
Phosphoric acid,	.065	.048
Nitrogen,	.338	.303
Insoluble matter,	.026	.048

Field C, Eastern Portion.

The part of Field C east of the experiment plats is 183 by 131 feet, and contains .55 acre, being divided into two equal portions by the strip of uncultivated land passing through the centre of the field. The fertilizer applied consisted of 300 pounds of fine-ground bone and 100 pounds of muriate of potash. A strip 20 feet wide was set off at the western side of the portion for special trials with vegetables, etc. The northern portion remaining was used for the production of carrots and the southern portion for globe mangolds. In both cases the seed was put in May 4 and the young plants appeared above ground the 14th. The field was kept free from weeds during the growing season, and the mangolds were harvested on October 9, yielding 3,840 pounds of roots, or 15,368 pounds per acre. The carrots were harvested October 11, giving 5,563 pounds, or 22,363 pounds per acre. The space west of the mangolds was used for trials with oats. Three varieties, sent on by J. A. Everett, Indianapolis, Ind., were tested. They were: No. 1, Colgarry Gray; No. 2, Rust Proof; and No. 3, White Superior Scotch. Two rows of each (89 feet long) were planted. The oats were sown in drills May 4 and germinated May 10.

Height of Oats.

[Inches.]

	June 5	June 12.	June 26.	July 3.
No. 1, Colgarry Gray, ...	8	15	23	30
No. 2, Rust Proof, ...	7	12	18	20
No. 3, White Superior Scotch, ...	9	15	26	30

The oats were somewhat affected by rust during the season, No. 2 suffering more than the others. June 29 the oats began to head out. Nos. 1 and 3 were cut July 16; No. 2, several days later.

Yield of Oats.

[Pounds.]

	Total Weight.	Grain.	Straw.	Per Cent. of Grain.
No. 1, Colgarry Gray, ...	38	15	23	39.50
No. 2, Rust Proof, ...	43	$4\frac{1}{2}$	$38\frac{1}{2}$	10.40
No. 3, White Superior Scotch, . .	41	$7\frac{1}{2}$	$33\frac{1}{2}$	18.30

The space west of the carrots was given to the raising of peas, Wisconsin tree bean, bush lima bean and potatoes. The peas were sent on for trial by James J. H. Gregory & Son, Marblehead, Mass., and were numbered 1, 2 and 3, there being one row of each. They were planted May 4, coming up about the 11th. June 11 No. 1 began to bloom, and June 14 Nos. 2 and 3, the different rows having then the following heights: —

	Inches.
No. 1, ...	12
No. 2, ...	6
No. 3, ...	11

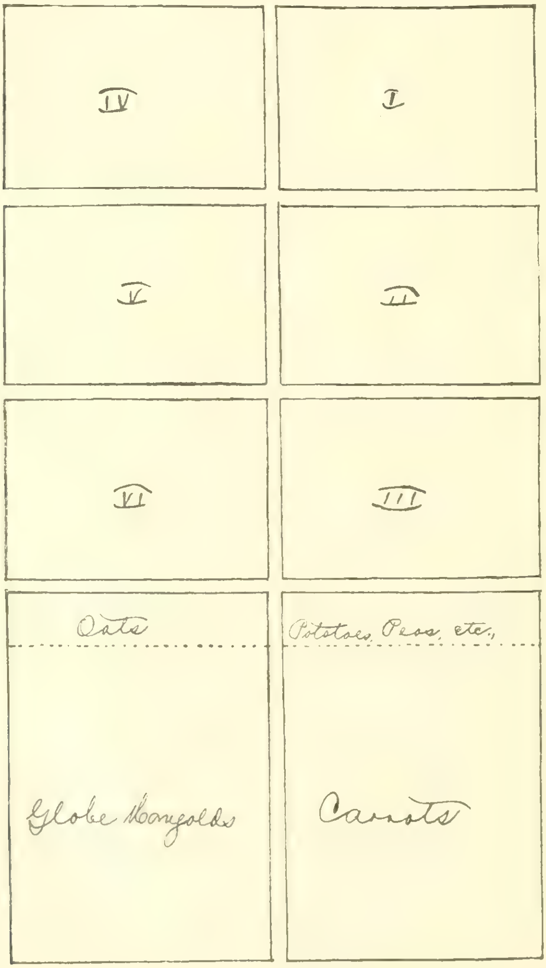
June 25 there were pods ready for picking on No. 1; June 29, on No. 2, with a few on No. 3. No. 1 proved to be the best yielder.

West of the peas was one row each of bush lima beans and Wisconsin tree beans. The lima beans were sent on by the United States Department of Agriculture and the Wisconsin tree beans by J. A. Everett. The Wisconsin tree beans came into bloom June 25 and the bush lima beans on July 9, but the latter failed to reach maturity.

The remaining row was planted to a variety of potatoes, Nos. 1–6 of which were sent on by J. A. Everett, Indianapolis, Ind., and No. 7 by Richard Nott, Burlington, Vt. They were planted May 4, and May 17 No. 1 began to appear; Nos. 2, 3, 5 and 6 on the 20th; No. 7 on the 23d and No. 4 on the 24th. July 5 Nos. 1, 2, 3 and 6 were noted as coming into bloom, the others being a little later. August 22 the tubers were dug, and yielded as follows: —

No.	Name.	No. of Hills.	No. of Tubers.	Total Weight.		Marketable Tubers	Weight.		Small Tubers.	Weight.	
				lbs.	oz.		lbs.	oz.		lbs.	oz.
1	Early Everett, . .	5	68	10	14	34	7	12	34	3	
2	Rural New Yorker, .	6	53	9	12	39	8	10	14	1	4
3	Colossal, . . .	7	74	13	12	43	10	12	31	3	
4	Heavy Weight, . .	6	77	7	14	15	3		62	4	14
5	Everett's Six Weeks,	5	64	5	11	16	2	13	48	2	14
6	Green Mountain, .	6	68	12	4	40	9	15	28	2	5
7	Nott's Seedling No. 7,	2	19	3	9	13	3	3	6		6

Field "C," 1894.



Scale, 4 rods to 1 inch.

4. Experiments with Forage Crops (Twenty-seven).

Field D.

This field has been used for the past three years for the raising of a variety of reputed annual and perennial fodder crops, in the majority of cases new to our section of the country, to study their adaptation to our climate and soil. Some of them have since been raised on a larger scale successfully and profitably for the support of our dairy stock, as southern cow-pea, serradella, early-maturing soja bean, late-maturing soja bean, summer vetch and oats, summer vetch and barley, and vetch, oats and horse bean.

The field is 328 feet long and 70 feet wide, covering an area of 22,960 square feet, or .527 acre. The field was ploughed April 30, and May 1 a fertilizer mixture was applied at the rate of 600 pounds of fine-ground bone and 200 pounds of muriate of potash per acre. The fertilizer was applied broadcast and harrowed in. The different crops were planted in rows two and one-half feet apart, and were kept free from weeds throughout the season. They were arranged in the field during the past season in the following order, beginning at the west end: —

Prickly comfrey (*Symphytum officinalis*).
Alfalfa (*Medicago sativa*).
Kidney vetch (*Anthyllis vulneraria*).
Forest pea or flat pea (*Lathyrus sylvestris*).
Crimson clover (*Trifolium incarnatum*).
Alsike clover (*Trifolium hybridum*).
Medium red clover (*Trifolium medium*).
Sainfoin (*Onobrychis sativa*).
Japanese clover (*Lespedeza striata*).
Winter rape (*Brassica napus*).
Dwarf Essex rape (*Brassica napus*).
Serradella (*Ornithopus sativus*).
Vetch (*Vicia sativa*).
Bokhara clover (*Melilotus alba*).
Yellow lupine (*Lupinus lutens*).
Blue lupine (*Lupinus perennis*).
White lupine (*Lupinus alba*).
Southern cow-pea (*Dolichos sinensis*).

Horse bean (*Vicia faba*).
Early-maturing soja bean (*Soja hispida*).
Late-maturing soja bean (*Soja hispida*).
Silver-hull buckwheat (*Fagopyrum esculentum*).
Japanese buckwheat (*Fagopyrum esculentum*).
Common buckwheat (*Fagopyrum esculentum*).
Hog millet.
Golden wonder millet.
Spanish peanut.

Prickly comfrey (*Symphytum officinalis*), one row. The roots remained in the ground and wintered well during the winter of 1893–94, but were moved to their present position before the field was ploughed during the spring. The crop made a good growth, coming into bloom June 1. June 14 a part of it was cut for feeding (containing 86.67 per cent. moisture); the remainder was cut June 21. A second growth was made, which was cut during the fall. Following is given the analysis of the crop: —

	Per Cent.
Moisture at 100° C.,	86.67
Dry matter,	13.33
	100.00
Analysis of Dry Matter.	
Crude ash,	21.12
" fibre,	11.03
" fat,	2.06
" protein,	17.49
Nitrogen-free extract matter,	48.00
	100.00
Fertilizing Constituents.	
Moisture at 100° C.,	86.79
Dry matter contains: —	
Nitrogen,	2.80
Potassium oxide,	5.76
Phosphoric acid,	.87

This plant has been recommended as a forage crop for dairy stock which can be grown upon lands where leguminous crops fail to give satisfactory results.

Alfalfa (*Medicago sativa*), five rows. The seed was purchased of J. M. Thorburn & Co., New York, at twenty cents per pound. The seed was sown May 10, appearing above

ground May 17. The plants were twelve inches high July 3, fourteen inches high July 10. They suffered greatly from the effects of the dry weather. Following is an average analysis of the crop as hay: —

	Per Cent.
Moisture at 100° C.,	9.60
Dry matter,	91.40
	100.00

Analysis of Dry Matter.

Crude ash,	8.11
" fibre,	29.72
" fat,	1.65
" protein,	14.22
Nitrogen-free extract matter,	46.20
	100.00
Dry matter contains: —	
Nitrogen,	2.21
Potassium oxide,	1.55
Phosphoric acid,	.56

We have experimented with alfalfa at different times during the existence of the station, as will be noted from previous annual reports, with but little encouragement, as the crop suffered seriously from winter-killing.

Kidney vetch (*Anthyllis vulneraria*), five rows. The seed was sown May 10, the plants appearing May 25. Being a perennial, the growth of the present season was but slight. Below is given an analysis of the second growth, cut when in bloom: —

	Per Cent.
Moisture at 100° C.,	80.85
Dry matter,	19.15
	100.00

Analysis of Dry Matter.

Crude ash,	13.28
" fibre,	14.94
" fat,	3.51
" protein,	18.43
Nitrogen-free extract matter,	48.94
	100.00
Dry matter contains: —	
Nitrogen,	2.94
Potassium oxide,	1.75
Phosphoric acid,	.44

This plant prospers particularly upon a sandy soil, where other leguminous plants fail to give satisfactory returns. Its cultivation has of late received considerable attention in leading agricultural districts of Europe, for the above reason.

Flat pea or forest pea (*Lathyrus sylvestris*), six rows. Four rows remained in the ground from last season, but, having winter-killed somewhat, they were combined into two. On May 10 four rows were sown with seed obtained of Delano Bros., Lee Park, Neb. The young plants began to appear above ground June 6. The two rows of older plants made a good growth, coming into bloom June 18. It was cut July 12 for feeding, having then formed a number of pods. The sample for analysis was taken at this time: —

	Per Cent.
Moisture at 100° C,	78.80
Dry matter,	21.20
	100.00

Analysis of Dry Matter.

Crude ash,	9.35
" fibre,	28.27
" fat,	3.29
" protein,	27.26
Nitrogen-free extract matter,	31.83
	100.00
Dry matter contains: —	
Nitrogen,	4.36
Potassium oxide,	2.57
Phosphoric acid,	.90

Our results thus far obtained are not encouraging as far as adaptation to our clime and soil is concerned. The plant grows slowly during its earlier period, and has suffered repeatedly from winter-killing. Its high nutritive value may be judged from the above analysis. Whether it is acceptable to dairy stock as green fodder is somewhat in question. Judging from the observations of others, its best use is as silage.

Crimson clover (*Trifolium incarnatum*), six rows. The seed was sown May 10, appearing above ground the 15th. The growth during the early part of the season was promising, but the dry weather made practically a failure of it as

far as yield was concerned. The seed was purchased of J. M. Thorburn & Co., New York, at twelve and one-half cents per pound. As the crop had suffered from the drought considerably when reaching its maturity, the analysis was left for another season.

Alsike clover (*Trifolium hybridum*), six rows. The seed was sown May 10, the young plants beginning to appear above ground May 17. This crop was also seriously affected by the drought. The seed was obtained of J. M. Thorburn & Co., New York, at 25 cents per pound. An average analysis of the dry material is given below: —

	Per Cent.
Moisture at 100° C.,	9.93
Dry matter,	90.07
	100.00

Analysis of Dry Matter.

Crude ash,	11.90
" fibre,	26.17
" fat,	2.58
" protein,	16.63
Nitrogen-free extract matter,	42.72
	100.00
Dry matter contains: —	
Nitrogen,	2.48
Potassium oxide,	2.47
Phosphoric acid,	.74

This variety of clover has served us well in our meadows, it being seeded every two years at the rate of three to four pounds per acre, applied in the spring.

Medium red clover (*Trifolium medium*), five rows. The seed was sown May 10, first appearing above ground May 17. The crop did not make sufficient growth, on account of the dry weather, so that it was not cut. The seed was purchased of J. M. Thorburn & Co., New York, at fifteen cents per pound. Below is given an analysis of the dry fodder: —

	Per Cent.
Moisture at 100° C.,	11.41
Dry matter,	88.59
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	9.84
" fibre,	27.51
" fat,	2.13
" protein,	15.75
Nitrogen-free extract matter,	44.77
	100.00

Dry matter contains:—	
Nitrogen,	2.37
Potassium oxide,	2.48
Phosphoric acid,	.48

As this is the standard variety of clover for use on grass lands, no further discussion with regard to its merits is needed.

Sainfoin (*Onobrychis sativa*), four rows. The sainfoin remained in the ground from last year, the five rows being reduced to four. It started into growth well, and May 19 had commenced to bloom. It was sampled for analysis on May 28 and June 7, being cut for feeding June 11, when thirty inches high. It made a very good second growth, coming into bloom July 17.

	May 28 (Per Cent.).	June 7 (Per Cent.).
Moisture at 100° C.,	79.49	76.27
Dry matter,	20.51	23.73
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	8.06	9.56
" fibre,	22.62	22.49
" fat,	2.83	2.78
" protein,	15.95	18.11
Nitrogen-free extract matter,	50.55	47.06
	100.00	100.00

Fertilizing Constituents.

	Per Cent.
Moisture at 100° C.,	12.17
Dry matter contains: —	
Nitrogen,	2.99
Potassium oxide,	2.29
Phosphoric acid,	.86

This crop requires a calcareous soil and dry subsoil to do its best.

Japanese clover (*Lespedeza striata*), five rows. Seed sown May 10, first appearing above ground June 1. Being a perennial, the plant did not make sufficient growth to permit of an analysis. The seed was sent on by the United States Department of Agriculture.

Winter rape (*Brassica napus*), five rows. The seed was sown May 10, the young plants appearing above ground May 15. The seed was obtained of D. Landreth & Sons, Philadelphia, Pa. July 6 a portion of the rape was cut and fed out, being about fourteen inches high. Analysis at this period: —

	Per Cent.
Moisture at 100° C.,	83.34
Dry matter,	16.66
	100.00

Analysis of Dry Matter.

Crude ash,	22.44
" fibre,	12.26
" fat,	3.06
" protein,	15.16
Nitrogen-free extract matter,	47.08
	100.00

Dwarf Essex rape (*Brassica napus*), five rows. The seed was sown May 10, appearing above ground May 17. It made a good growth. July 6 one row was cut for feeding, being twenty-three inches high at the time. Analysis of a sample taken at this time showed it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	94.57
Dry matter,	5.43
	100.00

Analysis of Dry Matter.

	Per Cent.
Crude ash,	16.11
" fibre,	18.96
" fat,	3.80
" protein,	12.86
Nitrogen-free extract matter,	42.27
	100.00

Both varieties of rape are known as valuable fodder plants, as well as suitable crops for green manuring. Neither of these varieties come to blooming during the present season. They are expected to furnish valuable green fodder during the coming season.

Serradella (*Ornithopus sativus*), five rows. The seed was sown May 10, the plants appearing above ground May 21. The crop made a good growth, coming into bloom July 5. July 10 the plants were eleven inches high. The seed was purchased of Henry Nungesser, New York, at ten cents per pound. Following is given an average of the analyses of serradella made at the station : —

	Per Cent.
Moisture at 100° C.,	82.41
Dry matter,	17.59
	100.00

Analysis of Dry Matter.

Crude ash,	10.99
" fibre,	30.08
" fat,	2.41
" protein,	15.01
Nitrogen-free extract matter,	41.51
	100.00

Fertilizing Constituents.

Dry matter contains : —	
Nitrogen,	2.40
Potassium oxide,	.70
Phosphoric acid,	.84

We have used serradella for several years as a fodder crop for green fodder as well as silage. It has been raised in drills three feet six inches apart, yielding nine and one-half tons of green fodder per acre.

Spring vetch (*Vicia sativa*). The vetch was sown April 26, the seed coming up May 4. Seed was used at the rate of forty-five pounds per acre. The vetch came into bloom June 23, when twenty-eight inches high. The seed was purchased of J. M. Thorburn & Co., New York, at seven cents per pound. Analysis of the dried crop shows it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	9.90
Dry matter,	91.10
	100.00

Analysis of Dry Matter.

Crude ash,	8.24
" fibre,	30.27
" fat,	2.50
" protein,	15.09
Nitrogen-free extract matter,	43.80
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	8.21
Dry matter contains: —	
Nitrogen,	2.40
Phosphoric acid,	.86
Potassium oxide,	3.00

Bokhara clover (*Melilotus alba*), five rows. This crop remained in the ground from last year. It started into growth early, and on May 28 about twelve feet from the north end of each of the rows was cut for feeding, being about thirty inches high. June 7 another portion was cut for feeding, being thirty-six inches in height. June 18 the plants were coming into bloom at forty-five inches in height. June 22 the remaining portion was cut and fed out, being five feet in height. The seed was bought of Henry Nungesser, New York, at twenty cents per pound. Analysis of the crop collected at different dates gave the following results: —

	Per Cent.		
	May 28.	June 7.	June 22
Moisture at 100° C.,	87.43	80.99	75.86
Dry matter,	12.51	19.01	24.14
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	11.67	10.21	7.71
" fibre,	24.43	29.98	33.99
" fat,	3.51	2.76	2.88
" protein,	23.37	18.62	17.18
Nitrogen-free extract matter,	37.02	38.43	38.24
	100.00	100.00	100.00

This crop furnishes a liberal amount of fodder the first and second years. It should be cut before the plant reaches blooming, to preserve its succulent character. When advanced beyond that stage of growth it becomes coarse and is rejected by cattle.

Yellow lupine (*Lupinus lutens*), six rows. The seed was sown May 9, coming up May 23, but not germinating very well. July 12 the plants were coming into bloom, being about one foot in height. The seed was obtained of D. Landreth & Son, Philadelphia. Analysis of the plant shows it to have the following composition: —

	Per Cent.
Moisture at 100° C.,	86.05
Dry matter,	13.95
	100.00

Analysis of Dry Matter.

Crude ash,	11.14
" fibre,	27.10
" fat,	1.87
" protein,	17.84
Nitrogen-free extract matter,	42.05
	100.00

Fertilizing Constituents.

Dry matter contains: —	Per Cent.
Nitrogen,	2.66
Potassium oxide,	2.96
Phosphoric acid,	.61

Blue lupine (*Lupinus cœruleus*), three rows. The seed was sown May 9, the plants appearing above ground May 19. The plants came into bloom July 12, when about two feet in height. The seed was obtained of J. M. Thorburn, New York, at fifteen cents per pound.

White lupine (*Lupinus albus*), six rows. The seed was sown May 9, the young plants appearing above ground May 19. The plants came into bloom June 28. July 10 it was noted as being twenty-five inches high. The seed was purchased of D. Landreth & Son, Philadelphia, at six cents per pound. The composition of the plant is stated below: —

	Per Cent.
Moisture at 100° C.,	85.35
Dry matter,	14.65
	100.00

Analysis of Dry Matter.

Crude ash,	5.03
" fibre,	31.18
" fat,	2.41
" protein,	18.71
Nitrogen-free extract matter,	42.67
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	2.99
Potassium oxide,	1.73
Phosphoric acid,	.35

The lupines have served us well as green manuring crops. They may be seeded the beginning of May and are ready to be ploughed under the beginning of June, or may be seeded the latter part of August and are ready for ploughing under the latter part of September.

Southern cow-pea (*Dolichos sinensis*), five rows. The seed was sown May 9, the young plants appearing above ground May 19. The crop made a good growth, and was sampled for analysis on August 28 and October 2. The seed was purchased of D. Landreth & Son, Philadelphia. The analysis of the crop showed the following composition: —

	August 28 (Per Cent.).	October 2 (Per Cent.).
Moisture at 100° C.,	81.81	80.60
Dry matter,	18.19	19.40
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	11.20	9.96
" fibre,	17.87	20.52
" fat,	4.63	3.81
" protein,	17.19	16.41
Nitrogen-free extract matter,	49.11	49.30
	100.00	100.00

Two prominent varieties (Clay and Whippoorwill) have been raised successfully for a number of years, and have served us well as fodder crops either green or in the form of silage. None of these varieties mature seed in our section of the country.

Horse bean (*Vicia faba*), five rows. The seed was sown May 9, and first appeared above ground May 21. The plants first began to blossom June 28. July 10 the plants had reached a height of twenty-one inches. Below is given an analysis of the crop with pods forming: —

	Per Cent.
Moisture at 100° C.,	84.83
Dry matter,	15.17
	100.00

Analysis of Dry Matter.	Per Cent.
Crude ash,	5.75
" fibre,	28.17
" fat,	2.31
" protein,	16.68
Nitrogen-free extract matter,	47.09
	100.00

Horse bean stands our climate extremely well, the medium-sized variety seeming to be the best for us. We have during the past year raised it as a mixed crop with vetch and oats, and are pleased with the results.

Early-maturing soja bean (*Soja hispida*), raised on Field A. The seed was planted May 12, in drills two and one-half feet apart, at the rate of sixty pounds per acre. The young plants began to appear May 21. July 24 the plants on the different plats began to bloom. The yield of the crop was affected considerably by the dry weather. The crop was cut August 28, being put into a silo with corn for the production of a mixed silage. Below is given the analysis of the above crop: —

	Per Cent.
Moisture at 100° C.,	65.98
Dry matter,	34.02
	100.00

Analysis of Dry Matter.	
Crude ash,	9.69
" fibre,	17.28
" fat,	2.96
" protein,	20.13
Nitrogen-free extract matter,	49.94
	100.00

Later-maturing soja bean (*Soja hispida*), five rows. The seed was sown May 9, the young plants first appearing above ground May 21. The crop made a very vigorous growth, and was sampled for analysis at two different periods. The seed was obtained of J. M. Thorburn & Co., New York. The results of the examination of the samples collected are as follows: —

	August 28 (Per Cent.).	October 28 (Per Cent.).
Moisture at 100° C.,	70.91	68.11
Dry matter,	29.09	31.89
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	10.34	8.43
" fibre,	21.09	21.20
" fat,	3.11	2.34
" protein,	27.49	23.16
Nitrogen-free extract matter,	37.97	44.84
	100.00	100.00

Fertilizing Constituents.

Dry matter contains: —		
Nitrogen,	4.39	3.70
Potassium oxide,	–*	–*
Phosphoric acid,	–*	–*

* Not determined.

The above samples were raised on Field A, in 1892, in drills two and one-half feet apart, using seventy pounds of seed per acre, and securing on an average nine to ten tons per acre, which served as mixed ensilage with corn. The addition of leguminous plants, as clover, soja beans, serradella, etc., to corn for silage tends to counteract the acid reaction of the corn silage and furnishes a most acceptable article for feeding.

Silver-hull buckwheat (*Fagopyrum esculentum*), eight rows. The seed was sown May 9, the young plants appearing above ground May 16. It came into bloom June 18, and was cut for feeding out July 14, when about three feet in height. The seed was purchased of J. M. Thorburn & Co., New York, at ten cents per pound. An analysis of the dried crop, cut when in bloom, gave the following results: —

	Per Cent.
Moisture at 100° C.,	8.91
Dry matter,	91.09
	100.00

Analysis of Dry Matter.

Crude ash,	10.17
" fibre,	27.07
" fat,	2.55
" protein,	12.22
Nitrogen-free extract matter,	47.99
	100.00

Fertilizing Ingredients.

Dry matter contains: —	
Nitrogen,	1.95
Potassium oxide,	2.61
Phosphoric acid,	.94

Japanese buckwheat (*Fagopyrum esculentum*), seven rows. The seed was sown May 9, the young plants appearing above ground May 16. The first blossoms appeared June 18, and the crop was cut for green fodder July 14. The seed was purchased of J. M. Thorburn & Co., New York, at ten cents per pound. Below is given an analysis of the air-dried material, collected when in bloom: —

	Per Cent.
Moisture at 100° C.,	5.71
Dry matter,	94.29
	100.00

Analysis of Dry Matter.

Crude ash,	12.36
" fibre,	36.02
" fat,	2.22
" protein,	10.80
Nitrogen-free extract matter,	38.60
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	1.72
Potassium oxide,	3.51
Phosphoric acid,	.90

Both the silver-hull and Japanese varieties of buckwheat are on the whole larger plants and more foliaceous, and consequently yield a larger amount per acre. The Japanese variety seems to be the better of the two.

Common buckwheat (*Fagopyrum esculentum*), seven rows. The seed was sown May 9, the young plants appearing above ground May 18. June 18 the plants came into bloom. July 13 the crop was cut and fed out. The seed was obtained of D. Landreth & Son, Philadelphia, at five cents per pound. Below is given an analysis of the dried material: —

	Per Cent.
Moisture at 100° C.,	8.50
Dry matter,	91.50
	100.00

Analysis of Dry Matter.

Crude ash,	14.63
" fibre,	19.35
" fat,	3.04
" protein,	17.90
Nitrogen-free extract matter,	45.08
	100.00

Fertilizing Constituents.

Dry matter contains: —	
Nitrogen,	2.866
Potassium oxide,	3.504
Phosphoric acid,	.547

Common buckwheat yields somewhat less than the previously mentioned varieties, yet its nutritive character, under a corresponding system of cultivation and manuring, exceeds that of either one.

Hog millet, five rows. The seed was sown May 9, and began to come up May 17. This variety did not make as satisfactory growth as the next. It commenced to head out July 10, when twenty-four inches high. The seed was sent on by the Northrup, Braslon, Goodwin Company, Minneapolis, Minn.

Golden wonder millet, five rows. The seed was sown May 9, and began to come up May 17. The crop made a very good growth, and July 9 began to head out, when twenty-six inches high. The seed was sent on by the Northrup, Braslon, Goodwin Company, Minneapolis, Minn.

The millets both yield a large crop, but, as the seed was somewhat mixed, no weights have been taken.

Spanish peanut (*Arachis hypogæa*), two rows. The peanuts were planted May 10, coming into bloom July 16. As the amount of seed received and used was small, no data are given with regard to yield, etc. The peanuts were sent on by the United States Department of Agriculture.

We have seeded down during the early part of September, 1894, rye, winter vetch and rye and dwarf Essex rape, to secure, if possible, a supply of valuable green fodder during the middle or latter part of May. The winter vetch used for this purpose was especially imported, to test its adaptation to our climate. Previous experiments in this direction failed, as we suppose, on account of getting summer vetch in place of winter vetch.

Field "D." — Arrangement of Crops raised.

1892.		1893.		1894.
Artichoke.	W	Minnesota Corn.	W	Prickly Comfrey.
Prickley Comfrey.		White Lupine.		Alfalfa.
Pyrethrum.		Yellow Lupine.		Kidney Vetch.
Forest Pea.		Prickley Comfrey.		Lathyrus sylvestris.
Stachy's Tubers.		Pyrethrum.		Crimson Clover.
Kidney Vetch.		Forest Pea.		Alsike Clover.
		Late Soja Bean.		Medium Red Clover.
Winter Rape.		Kidney Vetch.		Sainfoin.
Sainfoin.		Early White Soja Bean.		Japanese Clover.
Yellow Trefoil.		Sainfoin.		Winter Rape.
Spring Vetch.		Early Black Soja Bean.		Essex Rape.
Bokhara Clover.		Cow-pea.		Serradella.
Summer Rape.		Serradella.		Bokhara Clover.
Horse Bean.		Spring Vetch.		Yellow Lupine.
Serradella.		Bokhara Clover.		Blue Lupine.
Soja Bean.		Horse Bean.		White Lupine.
Cow-pea.		Kaffir Corn.		Southern Cow-pea.
Jackson Wonder Bean.		Common Buckwheat.		Horse Bean.
Blue Lupine.		Japanese Buckwheat.		Late Soja Bean.
White Lupine.		Silver-hull Buckwheat.		Silver-hull Buckwheat.
Yellow Lupine.		Summer Rape.		Japanese Buckwheat.
Silver-hull Buckwheat.		Carrots.		Common Buckwheat.
Japanese Buckwheat.				Hog Millet.
Common Buckwheat.				Golden Wonder Millet.
	E		E	Spanish Peanut.

Scale of length, 50 feet to 1 inch.

Compilation of Analyses of Fodder Articles raised (1894).

Name of Crop.	Dry Matter.	100 Parts of Dry Matter contain —					Dry Matter contains —		
		Ash.	Fibre.	Fat.	Protein.	Nitrogen-free Extract Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
I. Leguminous Plants.									
Flat pea (*Lathyrus sylvestris*),	21.20	9.35	28.27	3.29	27.26	31.83	4.36	.90	2.57
Late-maturing soja bean,	29.09	10.34	21.09	3.11	27.49	37.97	4.39	–	–
Late-maturing soja bean,	31.89	8.43	21.20	2.34	23.18	44.84	3.70	–	–
Early-maturing soja bean,	34.02	9.69	17.28	2.96	20.13	49.94	3.22	–	–
Bokhara clover,	12.57	11.67	24.43	3.51	23.37	37.02	3.73	–	–
Bokhara clover,	19.01	10.21	29.98	2.76	18.62	38.43	2.97	–	–
Bokhara clover (in bloom),	24.14	7.71	33.99	2.88	17.18	38.24	2.90	–	–
Kidney vetch,	19.15	13.28	14.94	3.51	18.43	48.94	2.94	.44	1.75
White lupine,	14.65	5.03	31.18	2.41	18.71	42.67	2.99	.35	1.73
Yellow lupine,	13.95	11.14	27.10	1.87	17.84	42.05	2.66	.61	2.96
Southern cow-pea,	18.19	11.20	17.87	4.63	17.19	49.11	2.75	.58	1.04
Alsike clover,	90.07	11.90	26.17	2.58	16.63	42.72	2.48	.74	2.47
Medium red clover,	88.59	9.84	27.51	2.13	15.75	44.77	2.37	.48	2.48
Sainfoin,	23.73	9.56	22.49	2.78	18.11	47.06	2.99	.86	2.29
Spring vetch,	91.10	8.24	30.27	2.50	15.09	43.80	2.40	.86	3.00
Serradella,	17.59	10.99	30.08	2.41	15.01	41.51	2.40	.84	.70
Alfalfa,	91.40	8.11	29.72	1.65	14.22	46.20	2.21	.56	1.55
II. Miscellaneous Crops.									
Common buckwheat,	91.50	14.63	19.35	3.04	17.90	45.08	2.87	.55	3.50
Silver-hull buckwheat,	91.09	10.17	27.07	2.55	12.22	47.99	1.95	.94	2.61
Japanese buckwheat,	94.29	12.36	36.02	2.22	10.80	38.60	1.72	.90	3.51
Prickly comfrey,	13.33	21.12	11.03	2.06	17.49	48.00	2.80	.87	5.76
Dwarf Essex rape,	5.43	16.11	18.96	3.80	12.86	42.27	2.05	–	–
Winter rape,	16.66	22.44	12.26	3.06	15.16	47.08	2.42	–	–

Name of Crop.	Dry Matter.	Dry Matter contains —				
		Crude Ash.	Crude Fibre.	Crude Fat.	Crude Protein.	Nitrogen-free Extract Matter.
III. Mixed Crops (Dried).						
Vetch and oats, Field G, 1894,	91.05	4.48	27.78	2.62	22.56	42.56
Vetch and oats, Field B, Plat 15, 1894,	90.64	9.59	29.83	3.13	18.88	38.57
Vetch and oats, Field B, Plat 16, 1894,	90.65	8.69	31.28	2.63	15.16	42.24
Vetch and barley, Field B, Plat 13, 1894,	91.51	4.64	32.25	2.12	14.44	46.55
Vetch and barley, Field B, Plat 14, 1894,	90.76	7.80	32.58	2.56	13.36	43.70
Vetch, oats and horse bean, Field B, Plat 11, 1894,	89.81	10.36	30.07	2.70	18.93	77.94

The raising of fodders richer in nitrogenous constituents than our meadow growth (upland meadow hay) and pasture growth enables us to reduce the expenses for commercial concentrated feed stuffs to produce the desired well-balanced nutritive fodder rations for our farm live stock.

How can Forage Crops assist in improving the Productiveness of our Farm Lands?

The consideration of this important question claims the serious attention of every thinking and progressive farmer, for nobody questions the correctness of the view that a successful termination of his work depends in a controlling degree on a correct appreciation of the extent and character of his resources of plant food and on a liberal and intelligent use of the latter.

An insufficient supply of suitable manurial matter, required for the successful and liberal production of the crops to be raised, is at present universally recognized as being the most fatal circumstance in any system of farming for profit. Adopting this conclusion as the correct verdict of past and present experience in agricultural industries, it becomes most desirable, in the interest of satisfactory pecuniary returns, that every available manurial resource of the farm should be turned to account to its full extent. *To secure this end we are advised to begin the work with a timely thorough mechanical preparation of the soil under cultivation; to select the crops to be raised, as far as practicable, with reference to their tendency of economizing existing natural resources of plant food; to increase the latter to the full extent of suitable home-made manure on hand, and to supplement the latter liberally by buying commercial concentrated fodder articles and commercial fertilizer, as far as circumstances advise.*

To again discuss * briefly one of the means of developing and economizing manurial sources of the farm is the object of this chapter.

On Production and Selection of Fodder Crops.

A careful inquiry into the history of agriculture, down to the middle of the present century, has shown that the original productiveness of farm lands in all civilized countries, even in the most favored localities, has suffered in the course of time a gradual decline. This general decline in the fertility of the soil under cultivation has been ascribed, with much

* See annual reports for 1889 (page 189) and 1890 (page 135); also Bulletin No. 36.

propriety in the majority of instances, mainly to two causes, namely: a gradual but serious reduction in the area occupied by forage crops, natural pastures and meadows; and a marked decline in the annual yield of fodder upon large tracts of land but ill suited for a permanent cultivation of grasses, — the main reliance of fodder production at the time. A serious falling off in the annual yield of pastures and meadows was followed usually by a reduction in farm live stock, which in turn caused a falling off in the principal home resource of manurial matter. This chapter in the history of farm management has repeated itself in most countries. The unsatisfactory results of that system of farming find still an abundant illustration in the present exhausted condition of a comparatively large area of farm lands in New England.

Scientific investigations carried on during the past fifty years for the particular benefit of agriculture have not only been instrumental in recognizing the principal causes of an almost universal periodical decline of the original fertility of farm lands, but have also materially assisted by field experiments and otherwise in introducing efficient remedies to arrest the noted decline in the annual yield of our most prominent farm crops. As a scanty supply of manurial matter, due to a serious falling off of one of the principal fodder crops (pastures and meadow growth), was found to be one of the chief causes of less remunerative crops, and thus indirectly has proved to be the main cause of an increase in the cost of the products of the animal industry of the farm, — milk and meat, — it is but natural that the remedies devised should include, as one of the foremost recommendations, a more liberal production of nutritious fodder crops. The soundness of this advice is to-day fully demonstrated in the most successful agricultural regions of the world. An intensive system of cultivation has replaced in those localities the extensive one of preceding periods; although the area under cultivation for the production of general farm crops has been reduced, the total value of the products of the farm has increased materially in consequence of a more liberal cultivation of reputed fodder crops. The change has been gradual and the results are highly satisfactory.

Viewing our own present condition, we notice that well-paying grass land, good natural meadow, with rich and extensive pastures, are rather an exception than the rule. The benefits derived from indifferently yielding natural pastures are more apparent than real; the low cost of the production of the fodder is frequently, in a large degree, set off by a mere chance distribution of the manure produced. A continued cultivation of one and the same crop upon the same land, without a liberal, rational system of manuring, has caused in many instances a one-sided exhaustion of the land under cultivation. This circumstance has frequently been brought about in a marked degree by a close rotation of mixed grasses (meadow growth) and of our next main reliance for fodder, — the corn (maize). Both crops require potash and phosphoric acid in similar proportion (four parts potassium oxide to one part phosphoric acid), and both require an exceptional amount of the former. There is good reason to assume that the low state of productiveness of many of our farms, so often complained of, is largely due to the fact that crops have been raised in succession for years, which, like those mentioned, have consumed one or the other essential article of plant food in an exceptionally large proportion, and thereby have gradually unfitted the soil for their remunerative production, while a liberal supply of other important articles of plant food is left inactive behind. As the amount of available plant food contained in the soil represents largely the working capital of the farmer, it cannot be otherwise but that the practice of allowing a part of it to lay idle must reduce the interest on the investment.

Our personal observation upon the lands assigned for the use of the station has furnished abundant illustration of the above-described condition of farm lands. In one instance it was noticed that a piece of old worn-out grass land, after being turned under and properly prepared, as far as the mechanical condition of the soil was concerned, produced, without any previous application of manure, an exceptionally large crop of horse beans and lupine, — two reputed fodder crops. A similar observation was made during the

past season, when lands which for years had been used for the production of English hay and corn were used for the cultivation of southern cow-pea, serradella and a mixed crop of oats and vetch, to serve as green fodder for milch cows.

The field engaged for the production of these crops was not manured, because it was to be prepared for a special field experiment during the present season. An area of this land, which, under favorable circumstances, would not produce more than six tons of green grass at the time of blooming, yielded nine to ten tons of green vetch and oats, ten tons of green southern cow-pea and from twelve to thirteen tons of green serradella. The exceptional exhaustion of our lands in potash has been shown by detailed description of experiments with fodder corn in previous annual reports. (Field A, annual reports IV., V. and VI., 1886–88.)

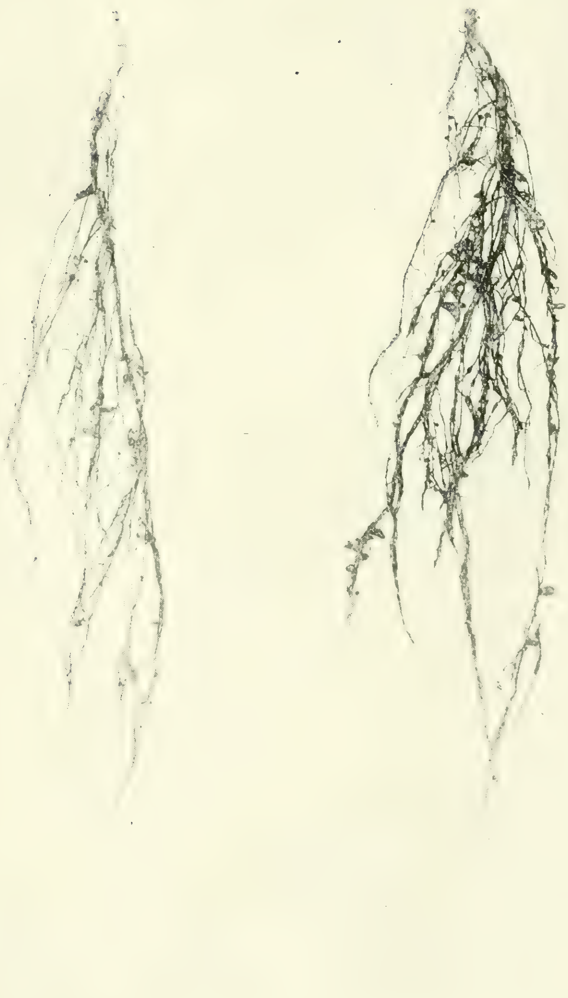
The results obtained during past years tend to confirm the opinion held by successful agriculturists, that dry grass lands which are in an exceptional degree inclined to a spontaneous overgrowing by an inferior class of fodder plants and weeds, if at all fit for a more thorough system of cultivation, ought to be turned by the plough and subsequently planted with some hoed crop, to kill off the foul growth and to improve the physical and chemical condition of the soil. These lands prove in many instances ultimately a far better investment when used for the raising of other farm crops than grasses. The less the variety of crops raised in succession upon the same lands, the more one-sided is usually the exhaustion of the soil, and the sooner, as a rule, will be noticed a decrease in the annual yield. The introduction of a greater variety of fodder plants enables us to meet better the differences in local conditions of climate and of soil, as well as the special wants of different branches of farm industry. In choosing plants for that purpose it seems advisable to select crops which would advantageously supplement our leading fodder crop (aside from the products of pastures and meadows), — the fodder corn and corn stover.

Taking this view of the question, the great and valuable family of leguminous plants, as clovers, vetches, lucerne, serradella, peas, beans, lupines, etc., is, in a particular

degree, well qualified for that purpose on account of its fitness to secure largely its nitrogen from the elementary nitrogen of the air by the aid of bacterial action. The photographs of the roots of several prominent leguminous forage plants, which accompany this chapter, show the swellings (tubercules) due to the bacterial action, — summer vetch, blue lupine, horse bean, serradella.

The following table may serve as an illustration of the relative economical value of various prominent fodder and forage crops.

The manurial value of the various crops mentioned depends for obvious reasons on the temporary current prices of their fertilizing constituents in the general market of commercial fertilizers.



C.I.G.

No. 1. Summer Vetch (*Vicia sativa*).

No. 2. Soja Bean (*Soja hispida*).

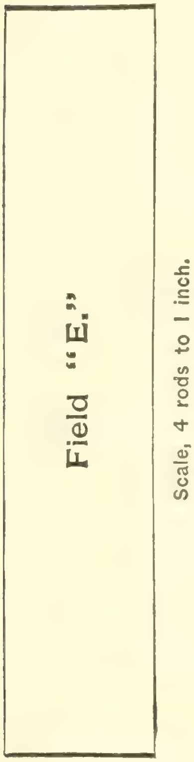
C.I.G.

No. 3. Blue Lupine (*Lupinus cœruleus*).

No. 4. Horse Bean (*Vicia Faba*).

Composition of Fodder Crops raised upon the Station Grounds.

NAME OF CROP. (SUITABLE FOR FEEDING.)	Nutritive Ratio.	Fodder Constituents (in Pounds) in 1,000 Pounds of Dry Matter.					Fertilizing Constituents (in Pounds) in 1,000 Pounds of Dry Matter.			Manurial Value per Ton of Dry Matter.
		Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein (Nitrogenous Matter).	Non-nitrogenous Extract Matter.	Nitrogen.	Phosphoric Acid.	Potassium Oxide.	
Medium clover (*Trifolium pratense*),	1:2.5 to 1:5.5	89.0	299.7	26.2	146.3	438.8	23.40	4.88	24.65	$10 64
Alsike clover (*Trifolium hybridum*),		116.7	261.8	26.6	162.2	432.7	25.88	7.81	24.72	11 86
Cow-pea (*Dolichos*),		69.2	235.9	24.8	145.9	524.2	23.40	5.79	14.44	9 86
Serradella (*Ornithopus sativus*),		116.9	324.9	23.7	149.6	384.9	23.94	8.04	24.12	11 15
Vetch (*Vicia sativa*),		82.4	303.7	25.0	150.9	438.0	24.14	5.47	12.75	9 95
Soja bean (*Soja hispida*),		75.1	212.6	59.9	154.0	497.5	24.78	4.66	16.53	10 39
Lucerne (*Medicago sativa*),		81.1	297.2	16.5	142.2	463.0	22.75	5.61	15.59	9 73
Herds grass (*Phleum pratense*),	1:5.5 to 1:9.5	53.3	328.7	20.1	85.2	512.7	13.95	4.97	16.54	6 75
Corn stover,		50.3	320.2	16.5	79.2	533.8	12.67	4.22	18.39	6 38
Fodder corn,		48.8	314.0	15.3	72.1	549.8	11.54	7.38	10.99	5 75
Oats (entire plant),		60.8	343.2	26.9	108.9	460.2	17.42	7.81	22.90	8 81
Barley (entire plant),		49.5	291.2	27.6	102.6	529.1	16.42	6.44	19.53	8 02
Millet,		54.9	335.4	17.4	75.9	516.4	12.14	5.03	10.89	5 66
Hungarian grass (*Setaria italica*),		71.5	246.6	10.1	93.8	578.0	15.01	6.24	13.50	7 00
Japanese buckwheat,		123.6	360.2	22.2	108.0	386.0	17.28	9.04	35.21	9 95
Sugar beets,	1:9.5 to 1:13	46.4	60.0	6.5	108.4	778.7	17.34	5.41	18.57	8 12
Ruta-bagas,		97.5	118.3	15.3	110.1	658.8	17.62	10.76	41.05	10 77
Mangel-wurzels,		90.6	79.4	8.8	103.7	717.5	16.59	7.32	30.13	9 08
Carrots,		81.4	95.3	25.0	88.4	709.9	14.14	10.02	54.11	10 61



5. Trial of an Early Variety of Minnesota Dent Corn (Huron).

Field E.

The field is 260 feet long and 48 feet wide, containing 286 acres. The field was ploughed April 24; it was fertilized May 7, at the rate of 600 pounds of fine-ground bone and 300 pounds of muriate of potash per acre, applied broadcast and harrowed in. May 8 the corn (variety Huron) was planted, six quarts of seed being used for the plat. The corn appeared above ground May 19. The field was cultivated and hoed June 7 and 26. September 1 part of the corn was cut and stocked, while the remainder was fed out. Owing to the dry season, this trial with the corn was not a fair one, as the development of the crop was greatly retarded.

6. Field Experiments with Different Commercial Phosphates to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates.

Field F.

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by a systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition to the full extent of existing circumstances. During the same period a crop was raised every year. These crops were selected, as far as practicable, with a view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow-pea, vetch and serradella) followed each other in the order stated.

1890. — The field was subdivided into five plats, running from east to west, each twenty-one feet wide, with a space of eight feet between adjoining plats.

The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and of nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate (floats) and dissolved bone-black. The market cost of each of these articles controlled the quantity applied, for each plat received the same money value in its particular kind of phosphate.

Cost per Ton.

Phosphatic slag,	$15 00
Mona guano (West Indies),	15 00
Florida rock phosphate,	15 00
South Carolina phosphate (floats),	15 00
Dissolved bone-black,	25 00

Analyses of Phosphates used.

[I., phosphatic slag; II., Mona guano; III., Florida phosphate; IV., South Carolina phosphate; V., dissolved bone-black.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture,	0.47	12.52	2.53	0.39	15.96
Ash,	–	75.99	89.52	–	61.46
Calcium oxide,	46.47	37.49	17.89	46.76	–
Magnesium oxide,	5.05	–	–	–	–
Ferric and aluminic oxides,	14.35	–	14.25	5.78	–
Total phosphoric acid,	19.04	21.88	21.72	27.57	15.82
Soluble phosphoric acid,	–	–	–	–	12.65
Reverted phosphoric acid,	–	7.55	–	4.27	2.52
Insoluble phosphoric acid,	–	14.33	–	23.30	0.65
Insoluble matter,	4.39	2.45	30.50	9.04	6.26

The following fertilizer mixtures have been applied annually to all the plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag,	127
	Nitrate of soda,	43
	Potash-magnesia sulphate,	58
Plat 2 (6,565 square feet),	Ground Mona guano,	128
	Nitrate of soda,	43½
	Potash-magnesia sulphate,	59
Plat 3 (6,636 square feet),	Ground Florida phosphate,	129
	Nitrate of soda,	44
	Potash-magnesia sulphate,	59
Plat 4 (6,707 square feet),	South Carolina phosphate,	131
	Nitrate of soda,	44½
	Potash-magnesia sulphate,	60
Plat 5 (6,778 square feet),	Dissolved bone-black,	78
	Nitrate of soda,	45
	Potash-magnesia sulphate,	61

The phosphatic slag, Mona guano, South Carolina phosphate and Florida phosphate were applied at the rate of 850 pounds per acre; dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the rate of 390 pounds per acre.

Potatoes were raised upon the plats in 1890; in 1891 winter wheat was employed (for details see ninth annual report); in 1892 serradella was the crop experimented with (see tenth annual report); and in 1893 a variety of Dent corn, Pride of the North (see eleventh annual report).

1894. — During the preceding season it was decided to ascertain the after-effect of the phosphoric acid applied during previous years by excluding it from the fertilizer applied. In addition, to secure the full effect of the phosphoric acid stored up, the potassium oxide and nitrogen were increased one-half, as compared with preceding seasons. A grain crop (barley) calling for a liberal amount of phosphoric acid was chosen for the trial. The field was ploughed April 17, the fertilizer being applied broadcast April 26, and harrowed in. Below is given a statement of fertilizer applied: —

Plat 1 (6,494 square feet), ...	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet), ...	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet), ...	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet), ...	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet), ...	67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

May 2 the barley was sown in drills two feet apart, at the rate of two bushels per acre. May 8 the barley was coming up on the plat. The field was kept free from weeds by cultivation.

Height of Plants.

[Inches.]

	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.
June 12, ...	14	13	10	14	14
June 18, ...	18	15	12	16	16
June 26, ...	28	26	21	24	27

June 26 the plants on plats 1, 2, 4 and 5 were beginning to show heads; No. 3 was somewhat behind the others. July 30 the barley was cut. The yield of barley from the different plats is given below: —

Yield of Crop (1894).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1, ...	490	169	221	34.49	65.51
Plat 2, ...	405	148	251	34.07	65.93
Plat 3, ...	290	78	212	26.89	73.11
Plat 4, ...	460	144	216	31.30	68.70
Plat 5, ...	390	118	272	30.26	69.74

Summary of Yield of Crop (1890–94).

Plats.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.	1894. Barley.
Plat 1, ...	1,600	380	4,070	1,660	490
Plat 2, ...	1,415	340	3,410	1,381	405
Plat 3, ...	1,500	215	2,750	1,347	290
Plat 4, ...	1,830	380	3,110	1,469	460
Plat 5, ...	2,120	405	2,920	1,322	390

Phosphoric Acid applied to and removed from Field.

[Pounds.]

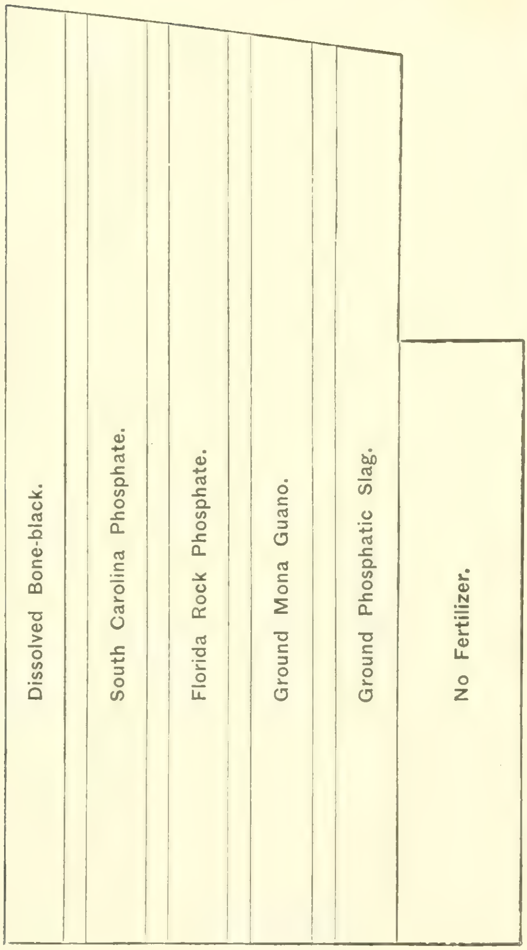
Plats.	1890.		1891.		1892.		1893.		1894.		Total Amount Added.	Total Amount Removed.	Total Amount Remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	-*	1.92	96.72	21.86	75.86
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	-*	1.64	72.04	19.02	53.02
Plat 3, .	109.68	2.40	-*	.69	28.01	6.05	28.01	5.95	-*	.76	165.70	15.85	149.85
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	-*	1.72	144.48	19.84	124.64
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	-*	1.49	49.36	18.57	30.79

* None.

Conclusions.

From the previous statement of comparative yield we find that the plat receiving dissolved bone-black leads in yield during the first two years, while for the third, fourth and fifth years the plats receiving insoluble phosphates are ahead, phosphatic slag being first, South Carolina floats second and Mona guano third.

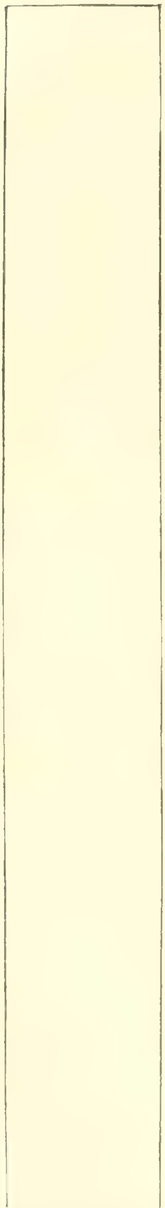
Field "F," 1894.



Barley.

Scale, 4 rods to 1 inch.

7. Experiments with Forage Crops (Vetch and Oats for First Crop, Hungarian Grass for Second).



Field "G," 1894.

Scale, 6 rods to 1 inch.

Field G.

The field is 700 feet long and 75 feet wide, and contains 52,500 square feet, or $1\frac{1}{5}$ acres. The field was ploughed Oct. 25, 1893. April 17 the artichokes were removed from the southern end of the field (see preceding annual report). It was fertilized with barnyard manure, applied at the rate of ten tons per acre. The field was again ploughed April 18. Vetch and oats was the crop selected for trial, being sown at the rate of forty-five pounds of vetch and four bushels of oats per acre. The field was seeded in two portions. The seed was sown on the northern portion April 20, coming up April 28. The southern portion of the field was seeded May 11, the plants appearing above ground May 19. The crop made a very satisfactory growth, and on June 23 the feeding of the green material from the northern portion began (the vetch being in bloom and the oats heading out), continuing until July 2, when that remaining was cut for hay. July 6 the cutting from the southern portion began, continuing until the 18th, when that remaining was cut for hay. Following is given a statement of the yield from the field :—

	Pounds.
Green material fed (19.12 per cent. dry matter),	6,875
Hay of vetch and oats (73.63 per cent. dry matter),	4,980

at the rate of 5,000–6,000 pounds of hay per acre.

Analysis of the material collected July 2 showed the following composition: —

	Per Cent.
Moisture at 100° C,	80.88
Dry matter,	19.12
	100.00

Analysis of Dry Matter.

Crude ash,	4.48
" fibre,	27.78
" fat,	2.62
" protein,	22.56
Nitrogen-free extract matter,	42.56
	100.00

July 21 the field was again ploughed and harrowed, and on the 23d was sown to Hungarian grass, which began to appear above ground July 28. Its growth was very materially affected by the dry weather. The crop was cut for feeding from September 25 to October 16, the total weight obtained being 4,456 pounds, having an average of 60 per cent. of dry matter.

Conclusions.

From the above figures it will be seen that the practice of introducing early-maturing mixed crops like vetch and oats in connection with valuable second crops like Hungarian, etc., deserves serious attention, on account of their superior fitness for dairy stock.

8. Field Experiments to study the Effect of Phosphatic Slag and Nitrate of Soda as compared with Ground Bone on the Yield of Oats and Corn.

East Field.

The field used for this experiment is situated south of the orchard and of the centre roadway. The soil consists of a loam, and has been under careful cultivation for several years. Its management during previous years can be seen from preceding annual reports.

1894. — During that season the operations on the field were as follows. (See accompanying diagram.) One acre on the upper (eastern) side was fertilized with: —

Plat I. { 600 pounds of fine-ground bone and
200 pounds of muriate of potash.

The remaining portion (1.8 acres) was fertilized at the rate of: —

Plat II. { 800 pounds of odorless phosphate,
200 pounds of muriate of potash, and
200 pounds of nitrate of soda per acre.

This corresponds per acre to: —

	No. 1 (Bone).	No. 2 (Phosphate).
Potassium oxide,	104	104
Phosphoric acid,	131	166
Nitrogen,	24	31

Composition of Fertilizer Applied.

	Per Cent.		
	Nitrogen.	Phosphoric Acid.	Potassium Oxide.
Ground bone,	4.09	21.86	–
Odorless phosphate,	–	20.84	–
Muriate of potash,	–	–	52.20
Nitrate of soda,	15.79	–	–

Cost of Fertilizers.

	Per Acre
Ground bone and muriate of potash, ...	$12 40
Odorless phosphate, nitrate of soda and muriate of potash, .	15 70

April 6 the odorless phosphate was applied to the lower portion of the field. The field was ploughed April 20–23. April 27 the remainder of the fertilizer was applied, and oats were sown on one acre set off at the north end of the field. May 5 the oats began to come up.

Height of Oats.

[Inches.]

June 5, ...	10
June 18, ...	19
June 26, ...	24

The oats began to head out June 25, and on July 25 they were cut, yielding as follows: —

Upper Part (Bone and Muriate), .35 Acre.

	Per Plat.	Per Acre.
Total weight when threshed (pounds), ...	760	2,171
Grain (pounds), ...	186	531

Lower Part (Odorless Phosphate, etc.), .65 Acre.

	Per Plat.	Per Acre.
Total weight when threshed (pounds), ...	2,120	3,261
Grain (pounds), ...	570	876

The remaining portion of the field was planted to corn (Pride of the North) on May 15; May 26 the corn was coming up. The field was cultivated and hoed June 8 and

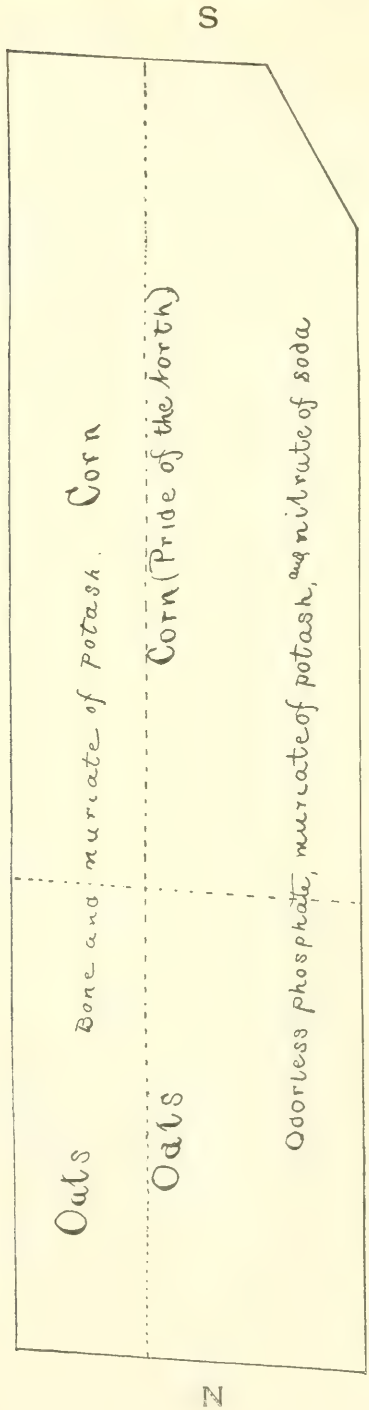
21 and July 2 and 11. August 29 the corn was cut for silage, yielding as follows: —

The upper part (bone and muriate), .7 acre, yielded 11,406 pounds, or 16,294 pounds per acre; the lower part (odorless phosphate, etc.), 1.2 acres, yielded 24,730 pounds, or 20,608 pounds per acre.

Summary of Yield (1894).

[Pounds.]

	Per Acre.	
	Plat 1 (Bone, etc.).	Plat 2 (Odorless Phosphate, etc.).
Oats (grain),	531	876
Oats (straw),	1,640	2,385
Corn,	16,294	20,608



Scale, 100 feet to 1 inch.

9. Experiments with Permanent Grass Lands (Meadows).

The meadows under consideration comprise an area of about 9.6 acres. The entire field up to 1886 consisted of old, worn-out grass lands, overrun with a worthless growth on its more elevated portion and covered with weeds and sedges in its lower portion. The improvement of the land by under-draining was commenced in 1886 and continued during the succeeding years. For details of the work see ninth and tenth annual reports (1891–92).

In the spring of 1893 a change was made in the *mode* of manuring of the grass plats. It was decided to study the effect of *a rotation of the three kinds of manures previously applied* upon the fields. The area was divided into three plats, Plat 1 (3.97 acres) being the area heretofore covered by plats 1 and 2; Plat 2 (2.59 acres) and Plat 3 (3 acres) correspond to plats 3 and 4 of previous years. The system of manuring adopted was as follows: —

Plat 1. — Wood ashes, 1 ton to the acre.
Plat 2. — Barn-yard manure, 8 tons per acre.
Plat 3. — Six hundred pounds fine-ground bone and 200 pounds muriate of potash per acre.

1894. — The above arrangement of plats was continued during the present season, and the fertilizers were applied in the same proportion to the same plats.

Yield of Hay (1894).

	Per Plat.			Per Acre.		
	Plat 1.	Plat 2.	Plat 3.	Plat 1.	Plat 2.	Plat 3.
First cut,	9.94	7.41	7.62	2.50	2.86	2.54
Second cut,	1.41	1.33	.56	.37	.51	.18
Total yield,	11.35	8.74	8.18	2.87	3.37	2.72

Yield of Hay (1889–94).

	Rate per Acre (Tons).		
	First Cut.	Second Cut.	Total.
1889.			
Plat 1, barn-yard manure, 18 tons to acre,	2.73	1.14	3.87
Plat 2, barn-yard manure, 8 tons to acre,	2.38	1.21	3.59
Plat 3, 600 pounds steamed bone and 200 pounds muriate of potash,	2.50	1.03	3.56
1890.			
Plat 1, barn-yard manure, 14 tons to acre,	3.80	1.00	4.80
Plat 2, barn-yard manure, 11 tons to acre,	3.25	1.34	4.59
Plat 3, as in 1889 (bone and muriate of potash),	3.00	.73	3.73
Plat 4, wood ashes, 1 ton to acre,	2.23	.68	2.91
1891.			
Plat 1, barn-yard manure, 8 tons to acre,	3.26	.72	3.98
Plat 2, barn-yard manure, 6 tons to acre,	2.99	.72	3.71
Plat 3, as in 1890 (bone and muriate of potash),	2.32	.51	2.83
Plat 4, as in 1890 (wood ashes),	2.32	.51	2.83
1892.			
Plat 1, as in 1891 (barn-yard manure),	2.77	1.04	3.81
Plat 2, as in 1891 (barn-yard manure),	2.70	.98	3.68
Plat 3, as in 1891 (bone and muriate of potash),	2.33	.64	2.97
Plat 4, as in 1891 (wood ashes),	2.18	1.02	3.20
1893.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.28	.77	3.05
Plat 3, barn-yard manure, 8 tons to acre,	2.62	.86	3.48
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	1.94	.64	2.58
1894.			
Plats 1 and 2, wood ashes, 1 ton to acre,	2.50	.37	2.87
Plat 3, barn-yard manure, 8 tons to acre,	2.86	.51	3.37
Plat 4, 600 pounds ground bone and 200 pounds muriate of potash to acre,	2.54	.18	2.72

The past season was marked by a severe drought, beginning with the month of July and extending into the fall, which affected the yield of the crop (second cut) to a serious extent.

10. Orchard. Experiments with Home-made Stable Manure, Unleached Wood Ashes and Various Mixtures of Fertilizing Materials on the Growth and Yield of Several Prominent Varieties of Fruit Trees (Apples, Pears, Peaches and Plums).

The land used for the experiments described below is situated along the east side of the station farm. It borders on the west on a meadow, and on the eastern side is separated from a natural grove by a private road thirty-five to forty feet wide.

The soil consists of a somewhat sandy loam, with indications of light springs in various parts of the field. The more prominent springs have been connected by drain pipes with the main drain of the adjoining meadow since the experiment began.

The entire field slopes gently and quite uniformly from east to west. Corn and grasses represent in the main the crops raised upon the ground in years preceding 1887.

The inferior yield and character of the crops of later years raised upon the land pointed towards an indifferent management, as far as the selection of crops and of manure is concerned. To destroy weeds and other objectionable local growths, it became advisable to introduce a thorough system of drill cultivation, which was begun in 1888.

In 1889 a series of field experiments with different manures was instituted, which has been continued up to the present time. The system of manuring employed from 1888 to 1894 is given below : —

Fertilizer applied Each Year from 1889 to 1894.

Plat I. — Home-made mixed barn-yard manure, 18,000 pounds (rate of 10 tons per acre).

Plat II. — Wood ashes, 1,800 pounds (rate of 1 ton per acre).

Plat III. — No fertilizer.

Plat IV. — Ground bone, 540 pounds (rate of 600 pounds per acre) ; muriate of potash, 180 pounds (rate of 200 pounds per acre).

Plat V. — Ground bone, 540 pounds (rate of 600 pounds per acre) ; sulphate of potash and magnesia, 360 pounds (rate of 400 pounds per acre).

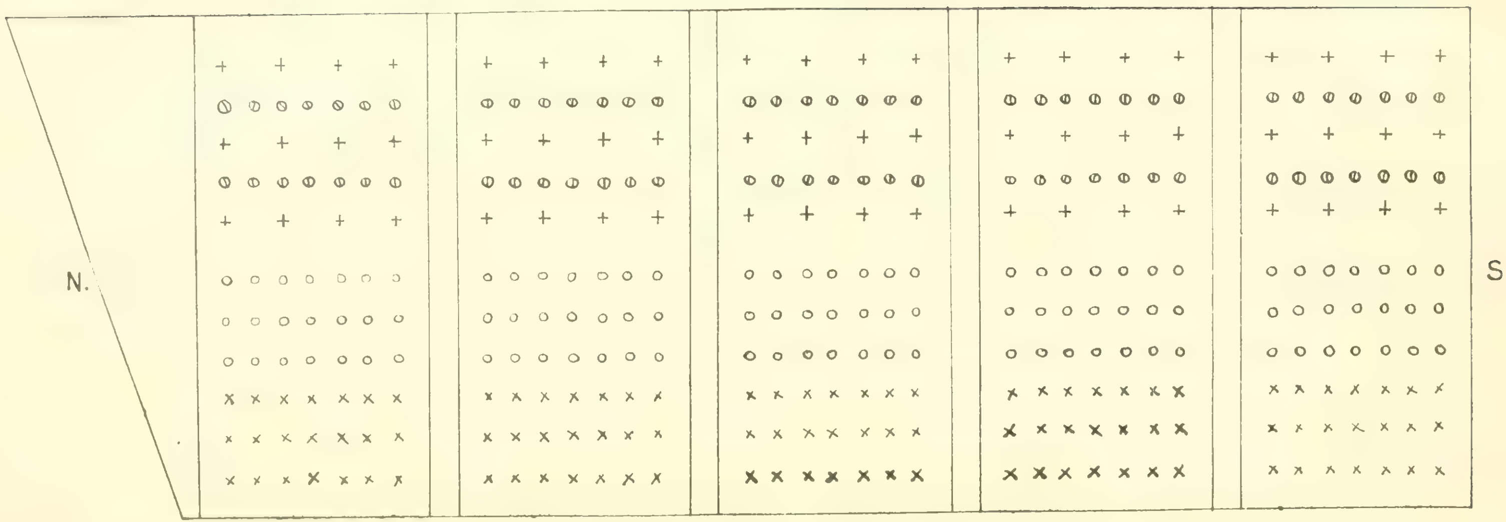
The details of the management of the field under discussion may be found in our annual report for 1893. In 1890 the main portion of the northern part was laid down as an orchard, a number of prominent varieties of apples, pears and peaches being set out in the order indicated in the accompanying diagram of the field. To these a number of varieties of plum trees was added in the fall of 1893. The system of cultivation was kept up as indicated in previous reports, barley and corn being raised (between the trees) in 1889; vetch and oats, Scotch tares and soja bean in 1890; barley and oats in 1891; Canada peas and oats, soja bean and Dent corn in 1892; vetch and oats, soja bean and barley in 1893; and in the fall of 1893 the orchard was seeded down to rye and grass. The space about four feet wide around the trees will be kept free from growth by means of the hoe, while the system of manuring as above will be continued for years to come, to ascertain the effect, if any, of the different systems of manuring on the growth and healthfulness of the stated varieties of trees under corresponding circumstances. The fertilizer will be applied as a top-dressing to each plat either in the spring or fall, as circumstances may advise.

Arrangement of Trees in Plats of Orchard.

Each plat contains the following varieties of trees, beginning at the south. The rows run east and west, and there are three trees in each row of apples, pears and peaches, and two in a row in case of plums: —

Apple.	Peach	Pear.	Plum.
Gravenstein,	Early Rivers, Beer's Smock,	Flemish Beauty, Seckel,	German Prune. German Prune.
Baldwin,	Coolidge Favorite, Early Crawford,	Sheldon, Bartlett,	Green Gage. Imperial Gage.
Roxbury Russet,	Old Mixon, Stump of the World,	D'Anjou, Lawrence,	Jefferson. Lombard.
Rhode Island Greening,	Late Crawford,	Buerre Bosc,	–

Orchard, 1894.



Scale 100 feet to 1 inch. + Apple. o Peach. x Pear. ⊘ Plum.

11. Observations in the Vegetation House.

1. Observations with different forms of potash, phosphoric acid and nitrogen on garden crops (C. A. Goessmann).
2. Experiments with Philadelphia tankage and dried blood as a nitrogen source for the raising of winter grain (rye) (C. A. Goessmann).
3. Leather refuse, — its value in agriculture (J. B. Lindsey).

From preceding descriptions of experiments carried on upon the fields of the station it will be noticed that our attention has been turned of late to a special study of the effect of different forms of nitrogen and potassium oxide on the growth of a series of prominent fruit and garden crops. The results of three years' observations regarding the latter are already reported in detail upon preceding pages (Field C).

To explain the striking differences noticed in the yields of some of those crops, in particular lettuce and tomatoes, when raised with the assistance of either muriate or sulphate of potash (upon Field C), it seemed advisable for confirmation of the results to transfer the investigations to the vegetation house, where, under better-defined circumstances, the special effects of the kind and form of the various articles of plant food supplied, as well as the most suitable quantity of each (nitrogen, potassium oxide and phosphoric acid), could be more clearly demonstrated. General observations with fertilizers in the vegetation house began four years ago.

1. Observations with Different Forms of Potash, Phosphoric Acid and Nitrogen on Garden Crops.

By C. A. Goessmann.

The first systematic attempt in the above-stated direction was made during the winter of 1892–93. The soil used in the vegetation house during that year was a sandy loam taken a few feet below the surface from a locality which at no time had received an additional supply of manurial matter from an outside source. It was sent through a screen before being used, to remove coarse vegetable matter (roots,

etc.). *Lettuce* and *New Zealand spinach* were used for the observation.

The relative proportion of fertilizer applied was: of potassium oxide, 3 parts; of phosphoric acid, 1 part; and of nitrogen, 1 part. The percentage of the different ingredients added to the soil was as follows: —

	Per Cent.
Potassium oxide,	.00026
Phosphoric acid,	.00009
Nitrogen,	.00009

The lettuce seeded in the boxes containing muriate of potash as the potash source proved a complete failure, as the young plants attained a height of only one and one-half inches, the color of the leaves changed into various shades of red, and growth ceased. In the other boxes the results were less striking, but the most satisfactory growth was obtained in those boxes in which sulphate of potash or sulphate of potash-magnesia furnished the source of potash.

Less marked was the difference in growth of the New Zealand spinach, the plants growing in the boxes containing muriate of potash being at first less vigorous; the difference in the yield at the close of the experiment was not so marked, except in regard to the time required to reach perfection. The most striking fact noticed with regard to these preliminary experiments was the apparently injurious effect of muriate of potash on lettuce. This result induced me to repeat the experiment in the vegetation house during the winter of 1893–94 (see annual report).

The soil turned to account during that season was obtained two feet below the surface of an abandoned pasture, which had not received any addition of manurial matter from an outside source for many years. The soil was screened, thus being freed from coarse material of every description. It consisted of a light loam. Twelve boxes (marked from 1 to 12), corresponding in size to those of the previous year (32 by 32 by 8 inches), were employed, each containing about three hundred pounds of the soil, being filled to within one

inch of the top. To secure a thorough mixing of the fertilizer and soil, they were worked together with the shovel and the mixture sent twice through the screen. The addition of the fertilizer to the soil was made two weeks in advance of the seeding. A greater variety of fertilizer mixtures was turned to account, including those of the preceding year. The potassium oxide was furnished by muriate of potash (1, 2 and 3), sulphate of potash (4, 5, 6 and 12), carbonate of potash-magnesia (7, 8, 9 and 10) and phosphate of potash (11). The phosphoric acid was supplied by dissolved bone-black (1, 2, 3, 4, 5, 7, 8 and 9), odorless phosphate (6), double superphosphate (10), phosphate of potash (11) and phosphate of ammonia (12). The nitrogen was added in the form of nitrate of soda (1, 4, 7, 10 and 11), sulphate of ammonia (2, 5 and 8), phosphate of ammonia (12) and organic nitrogen (dried blood) (3, 6 and 9). The relative ratio of essential fertilizing constituents applied was four parts potassium oxide, one part phosphoric acid and one part nitrogen. The percentage of the essential elements of plant food applied to the soil in boxes 1–9 (inclusive) was as follows: —

	Per Cent.
Potassium oxide,	.0004
Phosphoric acid,	.0001
Nitrogen,	.0001

The proportions for the remaining boxes are given below: —

	Per Cent.		
	Box 10.	Box 11.	Box 12.
Potassium oxide,	.0004	.0004	.0004
Phosphoric acid,	.0004	.0004	.0004
Nitrogen,	.0001	.0002	.0001

Following is a statement of the fertilizer mixtures used : —

Box 1.

128 grams muriate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 2.

128 grams muriate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 3.

128 grams muriate of potash.
100 grams dissolved bone-black.
155 grams dried blood.

Box 4.

128 grams sulphate of potash.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 5.

128 grams sulphate of potash.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 6.

128 grams sulphate of potash.
90 grams odorless phosphate.
155 grams dried blood.

Box 7.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
106 grams nitrate of soda.

Box 8.

360 grams carbonate of potash-magnesia.
106 grams dissolved bone-black.
78 grams sulphate of ammonia.

Box 9.

360 grams carbonate of potash-magnesia.
100 grams dissolved bone-black.
155 grams dried blood.

Box 10.

136 grams double superphosphate.
360 grams carbonate of potash-magnesia.
106 grams nitrate of soda.

Box 11.

200 grams phosphate of potash.
212 grams nitrate of soda.

Box 12.

145 grams phosphate of ammonia.
128 grams sulphate of potash.

Analyses of chemicals used in compounding the above mixtures will be found below : —

	Potassium Oxide.	Phosphoric Acid.	Nitrogen.
	Per Cent.	Per Cent.	Per Cent.
Muriate of potash,	46.00	-	-
Sulphate of potash,	50.20	-	-
Potash-magnesia sulphate,	24.32	-	-
Carbonate of potash-magnesia,	18.48	-	-
Phosphate of potash,	32.56	35.70	-
Dissolved bone-black,	-	13.88	-
Odorless phosphate,	-	18.42	-
Double superphosphate,	-	47.80	-
Phosphate of ammonia,	-	43.86	10.37
Dried blood,	-	4.02	10.00
Nitrate of soda,	-	-	14.28
Sulphate of ammonia,	-	-	19.59

A greater variety of garden vegetables was selected for trial. Each box was planted on October 11 with seed of the following : —

Lettuce, variety Hanson.
Spinach, variety New Zealand.
Beets, variety Egyptian.
Tomato, variety Essex Hybrid.

The boxes were treated similarly with regard to temperature and time of watering. To control the experiment, part of the vegetation house was turned to account to raise the same varieties of vegetables in the same soil, properly manured with vegetable compost from a successfully managed hot-bed. On October 17 the lettuce and spinach appeared, and by October 20 the remaining seeds had sprouted. The following notes relating to the different garden vegetables on trial may not be without interest in this connection, although still of a preliminary character : —

Lettuce. — The seed germinated well in all cases except with box 12, in which the number was somewhat scanty. During the first two or three weeks of growth the difference in the boxes was not very marked, although on November 20 1, 2 and 3 were noted as being generally of poorer quality than the others, with 4, 5 and 6 next. Nos. 2 and 5 were the poorest in their respective groups in which the nitrogen was furnished by ammonia salts. In boxes 8 and 12 the same failure was noticed.

The lettuce was removed from 9 and 10 January 10, having made a very satisfactory growth, and on January 20 from 7 and 8, also with a good growth.

Beets. — The seed germinated well in all cases, and during the first part of the growing period no very great differences were observed in the general appearance of the various boxes. The plants in 7, 8, 9, 10 and 11 proved the most satisfactory, being removed January 31.

Spinach. — This crop grew better in proportion in all the boxes than either of the others on trial. In 1, 2 and 3 it made a fair growth, although not as vigorous as in the remaining boxes; 4, 5 and 6 showed a more vigorous and rapid growth, while 7, 8 and 9 proved to be still more vigorous. Boxes 10 and 11 showed a corresponding relative increase in growth, the plants being removed on January 3, when in bloom.

Tomatoes. — The growth of the tomatoes in 1, 2 and 3 was less satisfactory than in most of the others. The degree of growth under the influence of different fertilizers may be noticed from the following table, expressing the heights of the plants at different periods of the observation: —

Height of Tomato Plants.

[Inches.]

DATE.	Boxes.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
December 5, . . .	5½	2¾	3	8	5	5	6½	8½	8	13½	9	8½
December 19, . . .	9½	6½	7	18	10	11½	11	14	14	24	21	21
January 9, . . .	26	10	25	36	22	22	28	31	32	45	44	43

The plants came in bloom as follows: in box 10, on December 18; in box 11, on December 20; in box 12, on December 23; in boxes 4, 5, 6, 7, 8 and 9, on January 1; and in boxes 1 and 3, on January 3. The plants in box 2 came in bloom February 15.

Fruit was formed first on the plants in box 10, noticed on January 17. It first appeared in box 12 on January 18; in boxes 4 and 9 on January 21; in box 3 on January 24; in box 1 on January 27; in box 8 on February 5; and in box 7 on February 28.

Fruit ripened in box 10 on February 20; in boxes 3, 4 and 12, on February 28; in box 9, on March 1; and in box 8, on March 7.

The plants grown in the soil manured with vegetable compost, as a sort of control experiment, made a very vigorous and healthy growth, but blossomed late and had formed no fruit up to March 8, although retaining their promising appearance.

Conclusions.

Lettuce did best in boxes 10, 9, 7 and 8; beets did best in boxes, 7, 10, 8, 4 and 11; spinach did best in boxes 10, 11, 7, 8 and 9; tomatoes did best in boxes 10, 12, 4 and 9.

1894–95. — During the past summer the boxes of the vegetation house were removed and replaced by others somewhat larger. The arrangement for sub-irrigation previously used in box 4 gave such good satisfaction that all of the boxes were similarly equipped.

The soil used for filling the boxes was obtained about six inches below the surface of land which had not been under cultivation for a considerable period. This soil was carefully screened, to remove coarse particles. Each box received about seven hundred and fifty pounds of the earth, to which the fertilizer had been applied and carefully mixed before filling in. The proportion of essential fertilizing ingredients applied to the soil is as follows: —

Boxes 1, 2, 3, 4, 5, 6, 7 and 8.

	Per Cent.
Potassium oxide,	.0056
Phosphoric acid,	.0014
Nitrogen,	.0014

Boxes 9, 10, 11, 12, 14 and 15.

	Per Cent.
Potassium oxide,	.0056
Phosphoric acid,	.0056
Nitrogen,	.0014

Below is given a statement of the various fertilizer mixtures employed, the amounts stated being for one thousand pounds of soil: —

Box 1.

512 grams muriate of potash.
424 grams dissolved bone-black.
620 grams dried blood.

Box 2.

512 grams muriate of potash.
424 grams odorless phosphate.
620 grams dried blood.

Box 3.

512 grams sulphate of potash.
424 grams bone-black.
620 grams dried blood.

Box 4.

512 grams sulphate of potash.
424 grams odorless phosphate.
620 grams dried blood.

Box 5.

1,440 grams potash-magnesia carbonate.
136 grams double superphosphate.
620 grams dried blood.

Box 6.

1,440 grams potash-magnesia carbonate.
424 grams odorless phosphate.
620 grams dried blood.

Box 7.

512 grams sulphate of potash.
136 grams double superphosphate.
424 grams nitrate of soda.

Box 8.

1,440 grams potash-magnesia carbonate.
136 grams double superphosphate.
424 grams nitrate of soda.

Box 9.

544 grams double superphosphate.
1,440 grams potash-magnesia carbonate.
424 grams nitrate of soda.

Box 10.

580 grams phosphate of ammonia.
512 grams sulphate of potash.

Box 11.

800 grams phosphate of potash.
312 grams sulphate of ammonia.

Box 12.

544 grams double superphosphate.
312 grams sulphate of ammonia.
512 grams muriate of potash.

Box 13.

100 pounds compost.

Box 14.

580 grams phosphate of ammonia.
512 grams sulphate of potash.

Box 15.

800 grams phosphate of potash.
312 grams sulphate of ammonia.

Box 16.

100 pounds compost.

The analyses of the chemicals used in compounding the above mixture are given on a preceding page. The analyses of the soil used in filling the boxes, and of the compost applied (13 and 16), will be found below: —

	Soil.	Compost.
Moisture at 100° C.,	7.610	25.750
Phosphoric acid,	.195	.432
Potassium oxide,	.233	.375
Nitrogen,	.065	.458
Organic and volatile matter,	11.380	41.570
Insoluble matter,	85.800	55.150

The boxes were planted October 11 and 12 with the following varieties of vegetables: —

Tomato (the Lorillard).
Turnip (Early American Red Top).
Lettuce (Rawson's New Hot-house).

February 1, tomatoes are looking best in boxes 9, 10, 11 and 8, in the order named; fruit has set on 9 and 10, also on 3 and 4, although the plants have not made a very stocky growth. Turnips are developed most in boxes 13, 16, 14, 15 and 11, in the order named; 9, 10, 2, 3, 4 and 7 have made considerable leaf growth, but have not much root development.

Following is given a summary of results to April 1, 1895. The detailed statement must of necessity be left for future presentation.

Turnips.

[Harvested Feb. 21, 1895.]

	Number of Roots.	Average Diameter of Roots.	Total Weight of Roots.	Total Weight of Leaves.	Average Length of Leaves.
Box 1,	4	2.7	14.00	48.00	17.25
Box 2,	4	2.6	16.00	37.00	14.50
Box 3,	5	2.5	18.00	44.00	14.60
Box 4,	5	2.5	20.00	46.00	15.80
Box 5,	–	–	–	–	–
Box 6,	–	–	–	–	–
Box 7,	4	2.7	17.50	48.00	15.00
Box 8,	–	–	–	–	–
Box 9,	5	1.7	7.00	33.00	13.40
Box 10,	4	2.1	8.50	29.00	15.50
Box 11,	4	2.9	26.00	42.00	17.00
Box 12,	3	2.0	7.50	31.00	14.00
Box 13,	4	4.3	60.50	25.50	15.75
Box 14,	4	4.3	57.00	50.00	17.25
Box 15,	7	3.8	48.00	64.00	16.25
Box 16,	4	4.0	45.00	21.00	14.75

Roots in boxes 5, 6 and 8 have not been harvested.

Tomatoes.

[Summary of observations to April 1, 1895.]

	In Bloom.	Fruit Set.	Ripe.		In Bloom.	Fruit Set.	Ripe.
Box 1,	March 25.	–	–	Box 9,	Jan. 7.	Jan. 20.	March 15.
Box 2,	March 20.	April 2.	–	Box 10,	Jan. 1.	Jan. 20.	March 10.
Box 3,	Jan. 6.	Jan. 22.	–	Box 11,	Jan. 4.	Feb. 1.	March 26.
Box 4,	Jan. 8.	March 5.	–	Box 12,	Jan. 20.	March 5.	March 12.
Box 5,	April 2.	–	–	Box 13,	Jan. 4.	March 1.	–
Box 6,	April 2.	–	–	Box 14,	Jan. 10.	March 1.	–
Box 7,	Feb. 7.	April 1.	–	Box 15,	Jan. 5.	March 20.	–
Box 8,	Jan. 15.	March 1.	–	Box 16,	Jan. 8.	March 1.	–

2. Experiments with Philadelphia Tankage and Dried Blood as a Nitrogen Source for the raising of Winter Grain (Rye).

By C. A. Goessmann.

1893–94. — The experiments described below were carried on for the purpose of comparing the value of dried blood and Philadelphia tankage as a nitrogen source for the raising of winter rye. The soil used in the experiment was obtained from a locality not under cultivation, and was carefully screened before use. Six boxes were filled, each with about seventy-five pounds of the earth.

Boxes 1 and 4 were fertilized with 180 grams of the following mixture: —

	Parts.
Double superphosphate,	40
Muriate of potash,	100
Dried blood,	100

Boxes 2 and 3 were fertilized with 180 grams of the following mixture: —

	Parts.
Double superphosphate,	40
Muriate of potash,	100
Philadelphia tankage,	100

The other two boxes received no fertilizer addition.

Sept. 21, 1893, winter rye was sown in the boxes. This began to appear above ground September 25, and October 12 the plants were thinned to five in a row, three rows in a box. During the winter the boxes were kept in the unheated portion of the vegetation house, and, to get as nearly as possible the outside conditions, snow was placed on the boxes at intervals, its melting furnishing the only water the boxes received during the winter. At the opening of spring the boxes were again regularly watered, during the summer receiving about four hundred cubic centimeters of water daily. No very striking differences were noticed in the appearance of the fertilized boxes, the average height being about thirty-six inches. The boxes receiving no fertilizer averaged thirty

inches in height. The plants were in bloom May 25. They were harvested July 27. They were kept until October 9, when the following weights were taken : —

Weight (Grams).

	Tankage.		Blood.		Nothing.	
Boxes,	2.	3.	1.	4.	5.	6.
Number of heads,	41	41	51	41	25	18
Total weight,	10.67	13.10	12.50	9.07	8.25	5.02
Number containing grain,	24	32	26	23	21	13
Number empty heads,	17	9	25	18	4	5
Weight of straw,	22.17	22.57	33.45	22.80	16.70	11.60

1894–95. — The experiments with winter crops were continued during the winter of 1894–95, as follows : —

Ten boxes were filled with the same kind of earth used in the beds of the hot-house, about 100 pounds being used per box, together with the following fertilizer mixtures : —

Box 1.

7.68 grams sulphate of potash.
24.38 grams bone-black.
24.38 grams nitrate of soda.

Box 2.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate
24.38 grams nitrate of soda.

Box 3.

7.68 grams sulphate of potash.
24.38 grams bone-black.
18.72 grams sulphate of ammonia.

Box 4.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
18.72 grams sulphate of ammonia.

Box 5.

7.68 grams sulphate of potash.
24.38 grams bone-black.
40.22 grams dried blood.

Box 6.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
40.22 grams dried blood.

Box 7.

7.68 grams sulphate of potash.
24.38 grams bone-black.
51.16 grams Philadelphia tankage.

Box 8.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate.
51.16 grams Philadelphia tankage.

Box 9.

7.68 grams sulphate of potash.
24.38 grams bone-black.
56.64 grams leather refuse.

Box 10.

7.68 grams sulphate of potash.
24.38 grams odorless phosphate
56.64 grams leather refuse.

The chemical composition of the above fertilizing ingredients can be ascertained from the table on page 277. The Philadelphia tankage contained seven and one-half per cent. nitrogen.

October 2, crops were planted in the boxes as follows: —

Boxes 1 and 2, winter rape.
Boxes 3 and 4, winter vetch.
Boxes 5, 6, 7, 8, 9 and 10, winter rye.

The seed germinated well and the plants made a good growth before winter, being left in the cold house and covered with snow during the winter season, to imitate as nearly as possible the outside conditions.

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3. Leather Refuse, — its Value in Agriculture.*

By J. B. Lindsey.

During the past few years claims have been made at various times that large quantities of leather shavings and the like have found their way into the so-called commercial fertilizers that are so widely used by the farmers of the United States. The writer has no means of knowing whether this claim is true or not. It should be the object of the fertilizer manufacturer to utilize all kinds of waste products that possess distinct manurial value. By so doing he not only benefits himself, but the farmer as well.

It was very early assumed from its chemical character, without any exact experiments upon which to base the assumption, that leather refuse would yield its nitrogen as plant food very slowly, if at all.

I. Historical Review.

1. Methods employed to make the Nitrogen available to Growing Plants.

The first method suggested, so far as the writer has been able to ascertain, was that prescribed by F. O. Ward † of England, in 1857, for turning to account woollen rags,

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* A portion of this article has already appeared in Agricultural Science, Vol. 8, Nos. 2 and 3, 1894.

† Report by the Juries of the International Exhibition, 1862. Reporter, A. W. Hoffman. Repertory of Patent Inventions, August, 1857, page 137.

wool, silk and leather clippings. The process as described was as follows: the refuse was introduced into an ordinary autoclave digester, and there kept for about three hours, surrounded by steam heated to a pressure of from three to five atmospheres. Wool required a higher temperature than leather, and silk than wool. The materials condensed a portion of the steam and absorbed its heat. This joint action converted the animal matter into a friable substance, which, however, still retained its original form and aspect. It was then ground fine, sifted and bagged. "The details of the process, the fuel and labor-saving arrangements that have been learned, point by point, by costly manufacturing experience, cannot," says Ward, "with propriety be divulged." The final product is described as a dark-colored powder. The nitrogen in the finished product is said to exist to a small extent as ready formed ammonia, being in combination with ulmic and humic acids developed during the process. It was stated at the time that this manufacturing process was carried on at large works on the Thames. The material for the most part was sold to manure manufacturers, who used it as an ingredient of their several fertilizing compounds, and it was "used by many farmers who are not aware of the fact." Ward says that, "while this material is not as active as some other forms of organic nitrogen, it possessed distinct value as a fertilizer." *

Edw. Toynbee,† in 1858, also described a process whereby leather and wool waste could be cooked in sulphuric acid, and be made more available as a fertilizer. He said that "to one centner of sulphuric acid four or five centners of wool or leather waste could be added." The writer does not see how such a large amount of leather could be added to the acid, as will be shown further on. L. Meyer ‡ speaks of dissolving all such refuse substances in warm sulphuric acid, and neutralizing the moist mass with bone.

A. Lipowitz § notes the fact that the Posner fertilizer

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* The writer does not know whether this process is still in operation in England for utilizing the leather, wool and silk wastes.

† Repertory of Patent Inventions, 1858, page 389. Jahresbericht Agric. Chem., 1859.

‡ Jahresbericht Agric. Chem., 1859, 228.

§ Allgem. Zeitung für deutsche Land. und Forstwirthe, 1859, 153.

factory utilizes all such kinds of waste as have already been referred to.

Runge * speaks of rendering leather and wool more available by dissolving them in a mixture of Glauber's salt and quick-lime. This chemist manufactured a fertilizer upon a large scale from these materials.

Reichardt † describes his method of subjecting the leather refuse to steam pressure, and then drying it quickly. After such a treatment he found 15.75 per cent. of the material to be soluble in boiling water, and that, after standing for some time, 20 per cent. could be dissolved. By treating the dry leather that had been subjected to steam with 20 to 40 per cent. sulphuric acid, he was enabled to dissolve from 22 to 29 per cent. of the leather in water. With a five per cent. solution of crystallized soda, 28.8 per cent. could be brought into solution. He therefore concluded that the best method was to subject the leather to the action of a weak soda solution.

Coignet's ‡ method was reported in 1874 by H. Mangon. Briefly stated, it is as follows: the refuse material is placed in a room having a cubic area of 20 meters. Directly outside of the room is a coke oven, connected with a chimney that has an opening into the room containing the material to be treated. Into this chimney are conducted jets of steam, so that the room is heated from 150° to 160° C. for several hours by this moist chimney air. Under these conditions the leather swells somewhat, and becomes dark, brittle, and can easily be rubbed to a powder.

Storer § says: "It is evidently with reference to this process that the statement has recently been made that certain manufacturers of fertilizers at Paris devote themselves particularly to the preparation of torrefied wool, horn, leather and even bone, the leather having first been steamed strongly to remove oil and gelatine."

L'Hote ‖ describes a method whereby such waste-material

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* Jahresbericht Agric. Chem., 1865.

† Zeitschrift für deutsche Landwirtschaft, 1865, 136. Jahresbericht Agric. Chem., 1865.

‡ Organ der Vereinf. Rübenz. Industrie in Œster-Ungarn, 1874, 32. Jahresbericht Agric. Chem., 1873–1874, 37.

§ *Agriculture* I., 382.

‖ Centralblatt für Agric. Chem., **5**, 258. Illustrirte Landw. Zeitung, 1874, No. 2, 18.

as wool, leather, etc., can be converted into sulphate of ammonia. He suggests dissolving the material in a ten per cent. solution of caustic soda in the cold. The substances will be partly dissolved, or their structure more or less destroyed. The jelly-like mass is then mixed with caustic lime till it becomes of a doughy consistency. It is then brought into iron retorts, and heated at first at as low a temperature as possible, in order to prevent the dissociation of the ammonia, which is caught in sulphuric acid. After the gas has been nearly driven off, the retorts are subjected to red heat. At the end of the operation a white powdery substance is left behind, consisting of carbonate of soda and caustic lime. By cooking this substance with water, caustic soda is formed and can be again utilized. By this method all the nitrogen is obtained. The resulting sulphate of ammonia is somewhat colored.

For utilizing leather Rümpler * suggests the following method: in lead or iron jacketed kettles, sulphuric acid of 50° B. is heated very hot, and leather stirred in till a dark-brown fluid is obtained. This fluid is then used to dissolve the phosphate of lime. He remarks that "the nitrogen is saved, and without doubt is much more available from the fact that the tannin is destroyed."

Erhardt † suggests that such refuse material be slowly burned in closed ovens, and the gas collected in moist muck till the latter becomes saturated. This muck mixed with superphosphate gave, he says, a quick-acting manure.

Deherain ‡ says that this leather refuse can be dissolved in sulphuric acid, and the excess of acid neutralized with phosphate of lime. In this way he claims a very active fertilizer can be obtained at a low cost.

The writer understands that this latter method has been in quite general use for many years by European manufacturers. Not only has leather been thus treated, but also a great variety of nitrogen-containing refuse materials. American manufacturers also subject various waste materials to the action of sulphuric acid, in order to render them more quickly available.

* Käufliche Düngestoffe. H. Rümpler, 1875 (Thaer Bibliothek).

† Jahresbericht Agric. Chem., 1880, 337.

‡ Deherain, *Chimie Agricole* [1892], 624.

From the many methods suggested for the utilization of leather waste, it is evident that in the older countries, specially England, France and Germany, this material, after having been submitted to some mode of treatment, is quite generally used, to a greater or less degree, in the manufacture of commercial fertilizers.

Petermann * says that "it is well known that certain Belgian and French manufacturers use leather in their products, but that such goods contain, in addition, nitrogen in other forms, such as blood, horn, meal, sulphate of ammonia and nitrate of soda." He further states that the "factories producing this material are numerous, and a considerable quantity is produced annually."

2. *Manurial Value of Prepared Leather Waste.*

The different experiments made to prove the value of leather have been conducted either with untreated finely ground leather, with torrefied leather, or with leather steamed under pressure.

Three different methods have been used in testing the agricultural value of leather: (*a*) by directly testing its fertilizing effect either in pot or plat experiments; (*b*) by artificially digesting it with a pepsin solution; (*c*) by noting the length of time required to nitrify it. The first method is by far the most interesting, and leads to direct results. The other two serve at least to confirm the results obtained by the first method.

A. Pot and Plat Experiments.

Very early experiments are not to be found in literature. The first experiment recorded was made by Ladureau,† and lasted but a single season. He found that 2,500 kilos. of torrefied leather yielded 30,100 kilos. of sugar beets, testing 8.83 per cent. of sugar; and 2,500 kilos. of the same leather plus 200 hectolitres of lime gave 38,600 kilos. of beets, with 10.10 per cent. sugar. The same area of land without leather yielded 20,000 kilos. of sugar beets, testing

* *Recherches de Chimie et Physiologie* [1885], 144.

† Annales Agron., 1878; *Loc. cit.*, 146.

10.93 per cent. sugar. Petermann remarks on these results as follows: "In spite of the increased yield obtained by using the leather, the experiment was not a success financially, and, further, the beets produced with the aid of the leather were poorer in quality than those without it."

In 1880 Petermann * carried out a series of experiments with ground steamed leather, to test its manurial value. It was very dry and brittle, and contained 7.51 per cent. of nitrogen and 0.81 per cent. of phosphoric anhydride soluble in hydrochloric acid.

The experiments were carried on in the plant house in pots, with oats; in the garden, with the horse bean (*Vicia faba*); and in the field, with sugar beets.

Experiments with Oats in Pots.

Each test was made in duplicate. The soil was what might be called a sandy clay, each pot holding 4,000 grams. The fertilizer was mixed with three-fourths of the soil of each pot. To the soil in each pot were added 0.25 gram of nitrogen, 0.30 gram of phosphoric acid and 0.20 gram of potash.

Results (Average of the Duplicates, expressed in Grams).

	Entire Plant.	Straw.	Chaff.	Grain.
Unmanured,	22.34	15.19	.95	6.20

Series I.

Nitrogen.				
(*a*) Leather,	34.85	26.65	1.25	6.95
(*b*) Dried blood,	51.91	36.68	1.82	13.41

Series II.

Nitrogen + Phosphoric Acid.				
(*a*) Leather + precipitated phosphate,	39.93	31.28	1.15	7.50
(*b*) Blood + precipitated phosphate,	51.97	36.45	1.91	13.61

* *Loc. cit.*, 144 Centrabl. Agric. Chem., **10**, 590.

Series III.

	Entire Plant.	Straw.	Chaff.	Grain.
Nitrogen + Phosphoric Acid + Potash.				
(*a*) Leather + precipitated phosphate + muriate of potash.	30.55	21.90	1.09	7.56
(*b*) Dried blood + precipitated phosphate + muriate of potash.	37.40	29.65	1.82	15.93

In observing the results of the experiments we notice especially, with reference to the grain produced, that the leather did not increase the yield to any appreciable extent over that of the unfertilized pots. When phosphoric acid and potash were applied with the leather a slight increase in the yield of grain was noticed, while in case of the dried blood plus the phosphoric acid and potash the yield was twice that of the unfertilized pot.

Garden Experiments with Horse Beans.

The soil was the same as in the previous experiment. Size of plats, 60 square meters. The fertilizer applied was leather and nitrate of soda. Nitrogen was applied at the rate of 58.5 pounds per acre.

Results per Plat.

	Stems and Pods in Kilos.	Beans in Kilos.	Beans per Acre in Kilos.
Unmanured,	9,869	1,131	37,700
Leather,	12,822	1,178	39,268
Nitrate of soda,	11,465	2,035	67,832

It will be observed that the leather produced only a slight increase in the yield of beans.

Field Experiments with Sugar Beets.

Same soil as in previous experiments. Each plat measured one are. The fertilizer was applied at the rate of $42\frac{1}{4}$ pounds of nitrogen and 52.8 pounds of phosphoric acid per acre.

Results per Hectare.

	Kilos.	Percentage Increase over Unmanured.
Unmanured,	34,830	–
Soluble phosphoric acid,	34,380	—1.5
Water and citrate soluble phosphoric acid,	34,290	—1.2
Citrate soluble phosphoric acid,	34,380	—1.5
Unmanured,	33,840	–
Leather + soluble phosphoric acid,	37,890	11.9
Leather + water soluble + citrate soluble phosphoric acid	37,180	10.7
Leather + citrate soluble phosphoric acid,	35,910	6.0
Unmanured,	32,940	–
Nitrate of soda + soluble phosphoric acid,	43,380	28.1
Nitrate of soda + water + citrate soluble phosphoric acid.	42,070	24.2
Nitrate of soda + citrate soluble phosphoric acid,	43,830	29.4

While the leather has shown its effect, it runs far behind the nitrate of soda. Petermann says that from a financial stand-point the leather shows a loss and the nitrate of soda a gain. Of his results the experimenter makes the following résumé: "With horse bean the leather shows practically no influence the first year; with oats and sugar beets an increase is noted, but this is slight when compared with that from blood and nitrate of soda." In a later publication Petermann says that in his experiments from 1880 to 1885 the various forms of nitrogen have shown the following relative worth: 1, nitrate of soda; 2, blood; 3, dissolved wool; 4, ground bone; 5, raw wool; 6, leather.

Deherain * gives the results of the following experiments conducted in the field at Grignon with ground leather. The results with wheat in 1880 and 1881 show the residual effect of the leather applied to potatoes in 1879: —

* *Chimie Agricole* (1892), 619.

	Potatoes.	Wheat.			
	1879. Hectolitres.	1880. Grain (Qtm.).*	1880. Straw (Qtm.).	1881. Grain (Qtm.).	1881. Straw (Qtm.).
Unfertilized, . . .	224	25.0	37.25	16.4	20.5
Leather, 2,000 kilos., .	295	27.5	40.00	23.4	38.7
Leather, 1,000 kilos., .	277	25.0	38.00	23.0	37.6

Deherain remarks that his experiments make it clear that the leather yields its nitrogen very slowly. He does not state whether the leather used had been steamed, roasted or was untreated.

Müntz † and Girard, in connection with their experiments on the nitrification of various nitrogen-containing organic substances, carried out also a series of field experiments with various nitrogenous materials. Each plat had an area of one are and received 1.25 kilos. of nitrogen the first year, together with the necessary quantity of phosphoric acid and potash. No manure was applied the second year. The soil was light and sandy, being quite favorable to nitrification. The plats were planted with fodder corn during both years.

Fodder Corn grown upon One Are (Dry Matter).

Form of Nitrogen.	1888. Kilos.	1889. Kilos.	Average of Both Years.
Nitrate of soda, ...	143	47	190
Dried blood, ...	130	48	178
Roasted horn, ...	123	52	175
Roasted leather, ...	91	61	152
No nitrogen, ...	59	43	102

The above results show that leather, even when roasted, is quite inferior in its action to dried blood and nitrate of soda.

* Qtm. (quintal metrique) = 100 kilograms.

† Ann. Agron., 17, 289-304; Biedermann's Centralblatt, **20**, 656.

Märcker * gives the following results obtained by Seyffert, at Halle, with cole-rape: —

FORM OF NITROGEN.	Yield in Grams.
No nitrogen,	75.5
Leather,	469.0
Steamed bone meal,	1,572.0
Blood,	1,654.0
Nitrate of soda,	2,607.5

In order to control the above experiment another test was carried out with oats by Julius Albert-Münchenhof: —

Yield.

FORM OF NITROGEN.	Grain (Grams).	Straw (Grams).	Roots (Grams).	Total (Grams).
No nitrogen,	5.2	15.7	14.3	38.2
Nitrate of soda,	48.9	62.6	27.9	139.4
Dried blood,	24.8	44.5	18.5	87.8
Leather,	13.3	22.2	13.6	49.1
Leather, fermented,	21.5	36.4	17.2	75.1

Märcker remarks that leather produced but a slight increase over the unfertilized, and that the quality of the grain was poorest when no nitrogen was used, or when leather was applied.

Dr. Wm. Frear very concisely presents the work done by Storer † as follows: —

Storer tested the manurial value of sheepskin and sole-leather, raw and roasted, on several soils in pots, applying various phosphatic and potassic salts in solution. The crop

* Jahresbericht Agr. Chemie, 1883, 241.

† Bulletin Bussey Institution, 2, 58-71.

used was buckwheat. The results were as follows (expressed in weight of total crop in grams) : —

	With Rain-water.	With Sulphate of Potash.	With Phosphate of Potash.	With Phosphate of Potash and Nitrate of Lime.
No leather used : —				
In Berkshire sand, ...	.200	.200	.155	.665 *
In Provincetown sand, ...	.170	–	.165	3.050
In loam and sand, ...	.270	–	.160	5.830
Raw sheepskin (20) : —				
In Berkshire sand (1,300), . . .	.100	.130	.055	.640 *
In Provincetown sand (1,450), . .	.080	–	.100	1.400
In loam and sand (1,320), . . .	.170	–	.120	4.020
Raw sole-leather (40) : —				
In Berkshire sand (1,300), . . .	.110	.115	.120	.280
In Provincetown sand (1,450), . .	.120	–	.110	2.820
In loam and sand (1,320), . . .	.130	–	.150	3.720
Roasted sheepskin (20) : —				
In Berkshire sand (1,300), . . .	.105	.190	.060	.250
In Provincetown sand (1,450), . .	.250 *	–	.470 *	.345 *
In loam and sand (1,320), . . .	.850	–	.700	3.060
Roasted sole-leather (40) : —				
In Berkshire sand (1,300), . . .	.220 *	.230	.210 *	.360 *
In Provincetown sand (1,450), . .	.910	–	1.750	3.120
In loam and sand (1,320), . . .	2.120	–	1.980	4.785

* Immature when harvested.

Storer says : "It will be seen plainly enough that, while neither the sheepskin nor the sole-leather supplied any nitrogenous food to the buckwheat plants, some nitrogen was unquestionably obtained by the plants from the roasted leathers, a little from the roasted sheepskin and a decidedly larger amount from the roasted sole-leather. . . . In all cases the light, bulky material tended to interfere with the growth of the plants. The roasted-leather jars exhibited a marked growth of fungus, the raw-leather jars showed none, corroborating the evidence as to the existence of available products in the roasted leather. There is but little in the

results above given to encourage the belief that roasted leather can have any definite money value as a manure."

Wagner * has made an exhaustive study of the value of different forms of nitrogen, having conducted 366 plat and pot experiments. The experiments were carried on for several successive years in a soil rich enough in lime to favor nitrification, and every effort was made to have the conditions equal in all cases. But a very brief résumé can be given at this time. One experiment was conducted for three successive years upon small plats of soil. Summer rye was planted the first year, summer wheat the second and carrots the third year. Placing the value of the returns from the nitrate of soda plats at 100, the other forms of nitrogen had the following relative worth : —

	First Year.	Average First and Second Years.	Average Three Years.
Nitrate of soda,	100	100	100
Blood,	67	67	69
Fish,	51	59	64
Steamed bone meal,	42	53	61
Leather,	13	12	20

Experiments were also conducted in pots with various soils, but the results cannot be noticed here.

In concluding his remarks relative to this subject Wagner says : —

When I take all things into consideration, . . . I think I may present the following figures as an expression of the relative value of nitrogen in different forms of nitrogen-containing material : —

Nitrate of soda,	100
Sulphate of ammonia,	90
Blood, horn meal and green crops,	70
Fine-ground bone, fish and tankage,	60
Stable manure,	45
Wool dust,	30
Leather,	20

* Die Stickstoff-düngung, etc., page 255.

So far as the writer has been able to ascertain, Wagner does not state the form of the leather used.

Taking the price of nitrogen in nitrate of soda at 14.8 cents, a pound of nitrogen in stable manure would be worth 6.7 cents and in leather 2.8 cents.

B. Artificial Digestion Experiments with Leather.

Stutzer and Klinkenberg were the first to propose this method. They argued that the amount of nitrogenous material that could be dissolved or digested would give a fairly correct idea of the value of the substance as a source of nitrogen for growing plants. They prepared the digestive fluid by extracting the inner lining of a pig's stomach, cut fine, with five litres of 0.2 per cent. hydrochloric acid for two days, filtering the solution, and preserving in glass-stoppered bottles, adding a few grams of salicylic acid to prevent fermentation. They submitted a variety of materials to the action of this solution. A few results are given below: —

Substance.	Per Cent. of Nitrogen digested.
Blood,	89.75
Leather (cooked, and then roasted),	39.19
Raw bone,	98.70
Steamed bone,	90.50

Drs. Shepard and Chazal * afterwards submitted a great variety of nitrogen-containing materials to the action of Stutzer's solution. Several of the results obtained are presented below: —

	Per Cent. of Nitrogen digested.
Roasted leather meal,†	37.80
Dried blood (black),	78.61
Fish scrap,	88.67

* See Report of Connecticut Experiment Station, 1885, page 117

† The authors remark that "this prepared leather was an excellent article, so far as preparation goes, and one capable of being used in the fertilizer trade without much fear of detection."

Johnson, Farrington and Winton,* instead of using Stutzer's solution, dissolved 5 grams of Golden Scale Pepsin in 1,000 cubic centimeters of 0.2 per cent. hydrochloric acid, and digested a variety of substances in this fluid. Their investigation is the most valuable we possess in this direction. A few of their results may be cited : —

	Per Cent. of Nitrogen digested.
Dried blood (two samples),	97.30
Dry ground fish,	71.20
Leather No. 3,†	23.40
Leather treated by benzine process,	35.90
Leather treated by superheated steam,	33.30
Mixed fertilizer A, containing 2.02 per cent. leather nitrogen,	23.40
Mixed fertilizer B, containing 2.00 per cent. leather nitrogen and 1.75 per cent. blood nitrogen,	55.60

In this connection it might be in place to mention the experiments recorded on the putrefaction of ammoniates, at first suggested by A. Morgen.‡ He put leather and horn meal in water to which a small amount of fecal extract had been added, and then allowed the solution to stand for thirty-one days at 30° C. The nitrogen made soluble was then estimated : —

In Experiment I., 10 grams material + 1,000 cubic centimeters water were used.

In Experiment II., 5 grams material + 1,000 cubic centimeters water + 5 cubic centimeters fecal extract.

In Experiment III. the same, with 10 grams material + 5 cubic centimeters fecal extract.

	Per Cent. of Soluble Nitrogen.
Leather meal, average of three experiments,	34.56
Horn meal, average of three experiments,	61.62

Johnson * repeated Morgen's work on a very large number of substances ; a few of the results are given below. He allowed his solution to stand two weeks : —

* *Loc. cit.*

† Fine and brittle, but method of preparation not known.

‡ Landw. Vers. Stat., 1880, **50** ; Biedermann's Centralblatt, **9**, 801.

	Per Cent. Nitrogen Soluble.
Blood,	76.80
Fish,	78.10
Fish,	54.60
Bone,	79.00
Leather No. 3,	12.20
Steamed leather,	42.30
"Prepared ammoniate" (probably leather),	35.70

Johnson remarks that "this test of putrefaction draws the same line between those classes of ammoniates that was drawn by the pepsin digestion."

C. NITRIFICATION EXPERIMENTS WITH LEATHER.

These experiments were carried out by Müntz and Girard * with quite a number of nitrogen-containing substances. They were conducted in the laboratory, and care was taken to see that the soil was properly aired, and that moisture, temperature, etc., were favorable to the experiment. Ordinary soil was at first used, the amount of nitrates present being carefully noted, and a small amount of the substances to be nitrified then added. After a certain time the nitrates were washed out with water and estimated. A very short résumé is here presented: —

Nitrogen Nitrified, per 100 Parts of Nitrogen added to the Soil.

	I. Thirty Days.	II. Thirty-nine Days.	III. Thirty-two Days.
Sulphate of ammonia,	75.00	83.76	83.76
Dried blood,	72.44	73.56	84.50
Roasted horn,	71.03	73.17	46.82
Roasted leather,	11.62	16.47	13.26

In order to study the influence of different kinds of soil upon the process of nitrification, the experiment was repeated with soils from various sections of the country: —

* Ann. Agron., **17**, 290; Agric. Science, **7**, 408–412. Deherain, *Chimie Agricole*, page 621.

Nitric Nitrogen found in Different Soils within a Certain Time.

	Light Soil of Joinville (Grams).	Chalky Soil (Grams).	Garden Earth (Grams).	Very Heavy Limey Clay (Grams).	Marsh Soil, Sour, Bretagne (Grams).
Sulphate of ammonia,	2.69	1.78	–	.510	None.
Blood, . . .	1.62	.73	–	.036	"
Roasted horn, . .	1.22	–	1.08	.029	"
Roasted leather, .	.41	.24	.55	.036	"

These experiments in general coincide with field and pot experiments as well as with artificial digestion experiments. It is worthy of note that the light sandy soil was most favorable to the process of nitrification, while the very heavy clay, and especially the sour marshy soil, was decidedly unfavorable to the action of nitrifying organisms.

II. Investigations concerning the Value of Leather Refuse made at this Station.

1. Can Leather be identified in Fertilizer Mixtures?

If one were to depend upon the microscope, it would certainly be an impossibility to recognize leather in finely ground fertilizer mixtures. Even if material of a fibrous structure were detected it would be nothing strange, for all flesh presents such a structure. After leather has been submitted to heat or pressure all structure is destroyed. Able microscopists, who have attempted to identify the leather under the microscope, report it an impossibility.

With chemical reagents one is more successful. At least, tannic or gallic acids, from their well-known reaction with an iron salt, are easily recognized; and, while one perhaps could not positively declare that the tannic or gallic acids present were derived from leather, it certainly would be highly probable.

Dr. C. W. Dabney,* when director of the North Carolina

* North Carolina Experiment Station Bulletin, No. 3, 1883: Horn, Leather and Wool Waste.

Experiment Station, published a bulletin in which he suggests that the best reagent for recognizing the tannic acid is a phosphoric acid solution of phosphate of iron. He states that, if leather be present in the substance examined, a purple color will soon appear if a few drops of this solution be added to the alkaline solution of the leather extract. The phosphoric acid solution of phosphate of iron was prepared as follows: ten grams of ferric chloride were dissolved in water, and sodium phosphate added till all the iron was precipitated as phosphate of iron. The phosphate of iron must be freshly prepared, otherwise it will dissolve slowly, if at all. The phosphate of iron was filtered and washed quite thoroughly with water, and both filter and precipitate brought into a beaker containing 400 cubic centimeters of water, to which had been added 40 grams of glacial phosphoric acid. A gentle heat dissolves the iron phosphate quite readily.

If a drop of pyrogallic acid is added to water, the solution made slightly alkaline with ammonia and then a cubic centimeter of the iron phosphate solution added, a dark purple color appears. If tannic acid is substituted for the pyrogallic acid, a dark wine color results. In order to recognize leather in a mixture, a small amount (one gram) of the substance supposed to contain it is placed in a beaker with 30–40 cubic centimeters of water, a few drops of sulphuric acid added, the liquid brought to boiling, filtered, a little of the iron phosphate solution added, and the solution then made slightly alkaline with ammonia. If leather is present, a dark purple to wine color will soon appear.

Should leather be present in a mixed fertilizer containing soluble phosphate of lime, the latter will of course be precipitated on the addition of ammonia, but this in no way interferes with the color reaction. The writer examined during the summer of 1893 quite a number of fertilizers officially collected in Massachusetts, but in no case was leather to be detected. When, however, ten per cent. of leather was added to a mixed fertilizer, and then tested with the phosphate of iron solution, the dark color, due to the presence of tannic or gallic acids, very distinctly appeared.

During the early summer of 1893 several samples of leather were received at the station. It was stated that large quantities of the material were on the market, and one could surmise, at least, that it might be used as a source of nitrogen in the manufacture of commercial fertilizers, organic nitrogen at the time being quite high in price. It was thought wise to submit the samples to several tests, and, for the sake of comparison, pure sole-leather, obtained by the writer at the cobbler's, and dried blood were also included.

Description of the Samples.

I. Sole-leather. — This leather was ground fine for future tests. Under the microscope it showed a distinct fibrous structure. It contained 2.76 per cent. of fat and 7.94 per cent. of nitrogen.

II. Steamed Leather. — Some of the finely ground leather was placed in pressure bottles, water added, and heated for six hours at 110 ° C. The leather was virtually subjected to three atmospheres of steam pressure. After treatment it had become very dark in color, and appeared as a jelly-like, amorphous mass. The microscope showed it to be devoid of any fibrous structure. The tannic or gallic acids were still easily recognized, showing that they had not been destroyed by the heat and pressure. When dry it became quite brittle, crumbling easily.

III. Coarse Leather sent to the Station. — This leather came in pieces, from the size of a walnut to that of a small hen's egg. It contained 37.47 per cent. of fat and 4.52 per cent. of nitrogen. The large amount of fat completely concealed its structure.

IV. Philadelphia Tankage. — The sample was very finely ground and quite dry. It contained 1.95 per cent. of fat, 7.80 per cent. of nitrogen and traces only of phosphoric acid. Its smell and general appearance indicated clearly that it was leather that had been roasted or steamed. To the eye it appeared to be lacking in fibrous structure, and with the microscope it appeared simply as a gelatinous mass.

V. Dried Blood. — It was an excellent sample, containing 12.71 per cent. of nitrogen and .64 per cent. of fat.

2. Artificial Digestion of Different Leathers.

The artificial digestion of the substances above described was carried out according to Stutzer's method. In the first series of trials both the pepsin and pancreas solutions were used. The preparation of the pepsin solution has already been described.

The pancreas solution was prepared by taking the fresh pancreas of an ox, cutting it fine, mixing it with sand and allowing it to stand twenty-four to thirty-six hours exposed to the air. It was then rubbed with lime water and glycerine (to every 1,000 grams of the pancreas-sand mixture use 3 litres of lime water and 1 litre of glycerine of 1.23 specific gravity), and the resulting fluid allowed to stand with occasional stirring for five days. It was then filtered through cloth to remove the coarse portions, heated to 40° C. for two hours, and finally filtered through folded filters and preserved in bottles. To prepare the pancreas solution used in the process of digestion, 250 cubic centimeters of the above-described solution were mixed with 750 cubic centimeters of soda solution. The soda solution contained 5 grams of carbonate of soda dissolved in 750 cubic centimeters of water. The pancreas solution thus prepared was heated for one to two hours at 37°–40° C., filtered to remove any flocky precipitate, and 100 cubic centimeters used for each test.

The results of the pepsin-pancreas digestion were as follows: —

		Per Cent. of Nitrogen digested.
I.	Sole-leather finely ground,	80.98
II.	Same leather after being heated six hours at 110° C. in pressure bottles with water,	97.23
III.	Coarse leather (free from fat),	52.00
IV.	Philadelphia tankage,	90.64
V.	Dried blood,	99.13

The above results are all very high, but this is not surprising, for the action of dilute alkalies on leather is well known and has been several times referred to. In the present case, after the various leathers had been submitted to the pepsin digestion there appeared to be no very great change either in their appearance or bulk. Blood, on the

other hand, was nearly all dissolved by the pepsin solution. As soon, however, as the leathers were submitted to the action of the pancreas solution a decided change was noted; the solution became quite dark in color and the larger part of the leather went into solution. While this method indicated a greater availability on the part of the sole-leather *after it had been submitted to steam pressure*, it nevertheless did not give a correct idea of the digestibility and consequent availability of the leather when compared with the dried blood.

The substances were therefore submitted to the action of the pepsin solution alone, with results as follows: —

		Percentage Digestibility of Nitrogen.
I.	Sole-leather,	13.70
II.	Sole-leather after steam pressure,	34.40
III.	Coarse leather,	–
IV.	Philadelphia tankage,	42.30
V.	Dried blood,	97.80

These results coincide very closely with those obtained by other investigators. The sole-leather itself proved very indigestible. It is possible that it might have proved somewhat less so if no hydrochloric acid had been added during the digestion.* The sole-leather *after* being subjected to the action of the steam pressure had a digestibility of 34.40 per cent., which coincides with results obtained by others for prepared leather, as the following samples show: —

	Percentage of Nitrogen digested.
Leather cooked and roasted (Stutzer),	39.19
Roasted leather meal (Shepard and Chazal),	37.80
Leather by benzine process (Johnson),	35.90
Leather by superheated steam (Johnson),	33.30

While, then, the action of steam and heat renders the leather somewhat more digestible and probably more available in the soil, it still has a digestibility below 50 per cent. Only the very poorest kinds of animal matter reach this low figure (50). The so-called Philadelphia tankage was also below 50 per cent. digestible, and may be classified with

* Connecticut Experiment Station, 1886, page 122.

the steamed or roasted leathers as regards its value. It is to be noted, as before mentioned, that the dried blood was nearly all digested by the action of the pepsin solution, and may be regarded as a very excellent standard with which to compare the various leathers.

General Conclusions relative to Raw, Roasted or Steamed Leather.

The results of the combined experiments in the field and in pots, together with artificial digestion experiments, and nitrification experiments, indicate that leather, either raw, roasted or steamed, is a very slow-acting form of nitrogen as a source of plant food. It certainly would be fraudulent to sell it in mixed fertilizers as a source of organic nitrogen, and the Massachusetts fertilizer law distinctly forbids it to be thus utilized. Carefully conducted experiments by Wagner give it a relative value of twenty, nitrate of soda being equal to one hundred. From the mass of evidence at our command it would seem that this figure about expresses its relative worth as a direct source of plant food. If it is offered for sale as a fertilizer, it should be sold as leather. When nitrogen in organic matter has a value of sixteen to eighteen cents per pound, nitrogen in raw, steamed or roasted leather should be worth but three to six cents per pound.

3. Action of Sulphuric Acid on Leather.

Deherain and others suggest that if leather be dissolved in sulphuric acid its nitrogen will be made as valuable as that in any form of animal matter. No experiments, however, are brought forward to prove such a statement, but it is generally understood that many European manufacturers thus turn leather waste to account. In order to study this question more closely a number of experiments were carried out by the writer, a few of which are presented below: —

Experiment I. — Sixty-five grams of 50° B. sulphuric acid were heated in a porcelain dish over a water bath of about 90° C., and 12 grams of leather gradually added. A dark, thick fluid resulted. Thirty cubic centimeters of water were then added to dilute the thick fluid somewhat, and bone ash was employed to dry off the resulting semi-fluid mass.

One hundred and thirty-six grams of superphosphate were obtained, which gave no tannic acid reaction.

Experiment II. — To 30 grams of 50° B. sulphuric acid, heated as above described, were added 12 grams of leather. A dark, thick paste was obtained, to which were added 25 cubic centimeters of water and 33 grams of bone ash. Seventy-three grams of superphosphate were obtained. The reaction of tannic acid was not strong.

Analyses of the two products were made as follows: —

	I. Per Cent.	II. Per Cent.
Moisture,	18.03	15.59
Soluble phosphoric acid,	14.84	11.80
Reverted phosphoric acid,	.69	1.50
Insoluble phosphoric acid,	1.43	3.38
Total phosphoric acid,	16.96	16.68
Nitrogen,	.70	1.20

Experiments III., IV., V., VI. — The previously described Philadelphia tankage was used in these experiments, and South Carolina floats in place of bone ash. The objects in view were to see (*a*) how much leather could be used without giving a tannic acid reaction, (*b*) to note, if possible, to what extent the leather interfered with the action of the sulphuric acid upon the floats, (*c*) to notice the approximate percentage of available phosphoric acid and nitrogen resulting, (*d*) to see if any nitrogen in the resulting superphosphates was soluble in water, (*e*) to note the amount of nitrogen in the superphosphate artificially digestible by Stutzer's solution. To make this latter estimation (*e*), 5 grams of superphosphate were stirred with water, filtered, and washed till the wash water was no longer acid. The portion not soluble in water was treated with pepsin solution.

Experiment III. — To 30 grams of 50° B. sulphuric acid, after heating, previously described, were added 12 grams of Philadelphia tankage. A thick, black dough resulted. It

was diluted with 25 cubic centimeters of water, appearing then as a thick, black fluid. To this fluid were added 60 grams of floats. The resulting superphosphate, after drying in the air for twenty-four hours, weighed 102 grams. The tannic acid reaction was quite strong.

Experiment IV. — To 30 grams of 50° B. acid were added 25 cubic centimeters of water and 70 grams of floats. The dry superphosphate weighed 101.5 grams.

Experiment V. — To 30 grams of 50° B. acid were added 9 grams of Philadelphia tankage, which resulted in a medium thick paste. Twenty cubic centimeters of water and 48.5 grams of floats were afterwards added. The dry superphosphate weighed 88 grams, and gave *no* tannic acid reaction.

Experiment VI. — To 30 grams of 40° B. acid 9 grams of Philadelphia tankage were added, resulting in a medium thick paste. This paste was diluted with 20 cubic centimeters of water, and 50 grams of floats were put in. Seventy-nine grams of superphosphate were obtained, which gave a strong tannic acid reaction.

These several products were analyzed : —

	III. Per Cent.	IV. Per Cent.	V. Per Cent.	VI. Per Cent.
Moisture,	14.14	14.13	14.86	–
Soluble phosphoric acid,	6.78	7.30	7.80	–
Reverted phosphoric acid,	1.22	1.60	.44	–
Insoluble phosphoric acid,	5.50	6.66	4.94	–
Total phosphoric acid,	13.50	15.56	13.18	–
Total nitrogen,	.81	–	.87	1.03
Nitrogen after artificial digestion,	.37	–	.25	.41
Per cent. of total nitrogen digested,	54.00	–	71.00	60.00
Soluble nitrogen,	trace	–	trace	–

It would appear that 9 grams of leather were all that could be added to 30 grams of sulphuric acid without getting the tannic-acid reaction. When, as in Experiment III., 12 grams of leather were added, the reaction for tannic acid was quite marked, and the nitrogen in the superphosphate had a digestibility of but 54 per cent. Experiment VI. indicates that 40° B. sulphuric acid was not quite strong enough to

thoroughly disintegrate the 9 grams of leather, for the tannic acid in the superphosphate was easily recognized, and the nitrogen was but 60 per cent. digestible. When 9 grams of the Philadelphia tankage were dissolved in 30 grams of 50° B. acid, no tannic acid could be recognized, and 70 per cent. of the total nitrogen was digestible. This is probably the average percentage of organic nitrogen that would be found digestible in mixed fertilizer, as offered for sale in our markets. Such a result is quite encouraging. It would seem from the analysis of IV. that the leather had not seriously interfered with the action of the sulphuric acid upon the floats. We have in the four experiments above cited added rather too much phosphate rock and water, and in the two following experiments less were added.

Experiment VII.—To 30 grams of 50° B. acid 9 grams of Philadelphia tankage were added, and then 12 cubic centimeters of water. To the thick fluid resulting 41 grams of floats were added. After standing twenty-four hours the material could be easily handled, and weighed 71.5 grams.

Experiment VIII.—To 30 grams of 50° B. acid 9 grams of Philadelphia tankage were added, producing a thick, pasty mass. Without the addition of water 28 grams of floats were stirred in, and after twenty-four hours the mass weighed 63 grams. The phosphate was quite black in color and sticky. It needed at least 5 to 7 grams more floats before it could be easily handled. It was plain that the sulphuric acid was not all neutralized. If no water were added to dilute the thick, pasty mass, it would be very difficult to work in the floats should large quantities be mixed.

Analyses.

	VII. Per Cent.	VIII. Per Cent.
Moisture,	17.95	16.95
Soluble phosphoric acid,	6.79	5.99
Reverted phosphoric acid,	2.16	1.62
Insoluble phosphoric acid,	1.94	1.56
Total phosphoric acid,	10.89	9.17
Total nitrogen,	.90	1.06

In Experiment VII. 8.95 per cent. of available phosphoric acid was obtained, with but 1.94 per cent. of insoluble acid and .90 per cent. of nitrogen; the phosphate was also in good mechanical condition and gave no tannic-acid reaction. The proportions of water, sulphuric acid, floats and leather appear to be about correct, and the percentages of available phosphoric acid and nitrogen as high as could be expected, with floats as a dryer.

Experiment IX. — In experiments III. to VIII. Philadelphia tankage was used as a source of leather.

In this experiment pure fine-ground sole-leather was used, to see if the sulphuric acid acted as strongly upon the pure leather as upon the prepared article. To 30 grams of 50° B. acid were added 9 grams of sole-leather, 20 cubic centimeters of water and 60 grams of floats.

The resulting phosphate weighed 98.5 grams.

Analysis gave the following results: —

	Per Cent.
Total nitrogen in the superphosphate,	.710
Total nitrogen after digestion,	.220
Total nitrogen digested,	69.000
Nitrogen soluble in water	.047
Per cent. of soluble nitrogen,	6.620

No tannic acid could be detected in this superphosphate. The artificial digestion of the nitrogen was made by taking 5 grams of the substance, washing out the soluble phosphoric acid with water, and proceeding in the usual manner.

It is to be noted from the above figures that the nitrogen in the sole-leather thus treated was as digestible as is the average animal matter sold for fertilizing purposes.

Practical Deductions.

The various experiments made would indicate that leather, sulphuric acid, water and floats should be mixed in about the following relative proportions: —

	Pounds.
Sulphuric acid, 50° B.,	2,000
Ground leather,	600
Water,	800
Floats,	2,700

The resulting mixture, when in fairly dry condition, would weigh approximately 5,000 pounds, shrinking about 18 to 20 per cent. It would have approximately the following composition: —

	Per Cent.
Moisture,	18.00
Available phosphoric acid,	8.50
Insoluble phosphoric acid,	2.00
Total phosphoric acid,	10.50
Total nitrogen,	.90

Two thousand pounds of sulphuric acid will not take up more than 600 pounds of leather and render the leather 70 per cent. digestible. If more is added, part of the latter, whether roasted or raw, will not be thoroughly acted upon by the acid. With 600 pounds of leather a thick paste results, which must be diluted somewhat with water in order to allow the sulphuric acid to act freely upon the floats. If bone ash should be used as a dryer, in place of ground phosphate rock, a higher percentage of available phosphoric acid and of nitrogen would result, as experiments I. and II. indicate.

Before submitting the leather to the action of the sulphuric acid, it would undoubtedly be better, after extracting the fat, to steam or roast it, in order that it may be easily pulverized. Raw, untreated leather is ground only with difficulty, and if the mechanical condition of the leather were poor, the action of the sulphuric acid would be imperfect.

Pot Experiments with Dissolved Leather.

By J. B. Lindsey and R. H. Smith.

In order to still further study the availability of the nitrogen in dissolved leather, pot experiments were instituted, and the result of our first year's trial is here presented.

The Pots used.

The pots were made of thin galvanized iron, and were seven and three-quarters inches in diameter and eight inches deep. A galvanized-iron tube, half an inch in diameter,

extended from the top to the bottom of the pot, connecting at the base with a second tube of the same material, one inch in diameter. This latter tube extended along the bottom of the pot and was perforated with small holes. The object of these tubes was to supply water partially from the bottom.

The Soil.

In order to test the availability of different sources of nitrogen, the soil to be used for such a purpose should be as poor in this ingredient as possible. If not naturally in such a condition, it should be rendered so by previous cropping. As we had not an ideal soil at hand for such a purpose, a sandy subsoil was selected that was poor in all of the several ingredients of fertility. It had the following composition: —

	Per Cent.
Moisture when tested,	14.25
Phosphoric acid,	.13
Potassium oxide,	.08
Nitrogen,	.09

The Fertilizers used.

In order to turn the nitrogen to the very best account, phosphoric acid and potash must be supplied in excess.

The sources of nitrogen were nitrate of soda, dissolved leather and Philadelphia tankage. The Philadelphia tankage has already been described. The dissolved leather was prepared as follows: to 210 grams of c. p. sulphuric acid of 50° B., heated to 80° C., were added 63 grams of finely ground sole-leather. The mixture was thoroughly stirred, and allowed to stand for half an hour; a dark pasty mass resulted. Forty-nine grams of water were added to thin the paste somewhat, and then finely ground calcium carbonate (marble) was added, to take up the excess of sulphuric acid, and enable us to secure a dry, easily handled material. We used the carbonate instead of the phosphate of lime as a dryer, in order to avoid an excess of phosphoric acid. After standing twenty-four hours the substance had dried out sufficiently to be easily handled and ground.

Double superphosphate was used as a source of phosphoric acid, and the potash was applied in the form of the double sulphate of potash and magnesia.

Composition of the Fertilizers.

	Dissolved Leather.	Philadelphia Tankage.	Nitrate Soda.	Double Superphosphate.	Sulphate of Potash and Magnesia.
Moisture,	-*	-*	2.09	5.74	8.10
Nitrogen,	.97	7.80	14.28	-	-
Soluble phosphoric acid,	-	-	-	38.38	-
Reverted phosphoric acid,	-	-	-	9.04	-
Available phosphoric acid,	-	-	-	47.42	-
Insoluble phosphoric acid,	-	-	-	.38	-
Total phosphoric acid,	-	-	-	47.80	-
Potassium oxide,	-	-	-	-	24.32

* Not determined.

Arrangement of the Experiment.

Eighteen pots were used in the experiment, fertilized as follows: —

Pots.	Source of Nitrogen.	Amount of Nitrogen applied (Grams).	Amount of Available Phosphoric Acid applied (Grams).	Amount of Potassium Oxide applied (Grams).
Pots 1, 2, 3,	Soil nitrogen,	-	1.20	2.40
Pots 4, 5, 6,	Philadelphia tankage,	.60	1.20	2.40
Pots 7, 8, 9,	Nitrate soda,	.30	1.20	2.40
Pots 10, 11, 12,	Nitrate soda,	.60	1.20	2.40
Pots 13, 14, 15,	Dissolved leather,	.30	1.20	2.40
Pots 16, 17, 18,	Dissolved leather,	.60	1.20	2.40

Pots 1, 4, 7, 10, 13, 16 were infected with a small quantity of cultivated soil, in order to note if the infection facilitated the nitrification of the organic nitrogen in case of our experiments. To each of these pots were also added 10 grams of air-slacked lime.

Filling the Pots.

About an inch of good clean gravel was first added to the pots, and then five centimeters of the well-mixed soil (three and one-half pounds). The fertilizer (one-half of the nitrate

of soda only at this time) was then thoroughly mixed with six and one-half pounds of the soil and added; this addition increased the depth nine centimeters. Two pounds of the mixed soil (three centimeters) were next put in, and finally the oats (one gram of seed per pot) were scattered in and covered with one-half pound of the soil. Twelve and one-half pounds of soil were therefore added to each pot, and filled it to within one centimeter of the top. After each addition of soil the pot was somewhat shaken, but the soil was not at all pressed in. The filling and planting were completed on April 25.

General Care of the Experiment.

The pots were set into a wagon running on an iron track. The floor of the wagon was surrounded with sides six inches deep. The space between the pots was filled with sawdust, which was kept moist, in order to keep the soil in the pots as cool as possible during the hot summer weather. The pots were carefully watched and kept sufficiently watered. A portion of this water was supplied from beneath, and the remainder was added to the surface with a sprinkling pot. Sometimes it became necessary to water twice daily. The pots were kept in the open whenever the weather permitted. During wet or windy weather, and at night, they were run under cover.

Notes.

The oats appeared April 30. When they were about two inches high, twelve plants were removed from each pot, as they appeared rather thick.

Appearance June 1.

Pots 1, 2, 3. Oats were eleven to thirteen inches high. They began to appear light green, up to yellow, and spindly.

Pots 4, 5, 6. Oats were but very little better in appearance than those in pots 1, 2 and 3.

Pots 7, 8, 9. Plants were dark green, stocky, and eleven to thirteen inches high.

Pots 10, 11, 12. Plants appeared dark green, very stocky, and were eleven to fifteen inches high.

Pots 13, 14, 15. Leaves broad, very dark green, and plants twelve to fifteen inches high.

Pots 16, 17, 18. Same as pots 13, 14, 15.

On June 4 pots 7, 8, 9 began to show nitrogen hunger, by appearing a lighter green; the ends of the leaves were turning yellow. The other half of the nitrate of soda was therefore added in 350 cubic centimeters of water to pots 7, 8, 9, 10, 11 and 12. From this time on (June 4) the plants in pots 1, 2, 3, 4, 5 and 6 grew quite slowly, had a light-green and spindly appearance. On June 22 the oats in all the pots (excepting 10, 11, 12) began to head. The latter showed the heads about a week later.

The plants retained their same relative appearance till harvested.

The plants in pots 10, 11, 12 were a deep rich green and stocky, but failed to mature much grain, as our tabulated results will show.

Harvesting.

The plants were harvested as they matured. The oats in pots 1, 2, 3 were cut, for example, July 23, while those in pots 10, 11, 12 not till August 10. They were cut close to the soil, put in large paper bags, and hung away to dry.

The photographs that follow show the relative appearance of the plants in pots 1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 14, 15, a short time before harvesting. The photographs of the plants in pots 10, 11, 12, 16, 17, 18 are not presented, for reasons that will be stated further on.

Comments.

Pots 1, 2, 3, 4, 5, 6 (see first photograph) have the same general appearance, though the latter contain a trifle more foliage. Pots 7, 8, 9, fertilized with .30 grams of nitrogen from nitrate of soda, and pots 13, 14, 15, with the same amount of nitrogen in the form of dissolved leather (see second photograph), compare to the eye very favorably one with the other. The plants in the nitrate pots are not quite as tall, but more stocky.

1 2 3 4 5 6

OATS.

0.00 g. nitrogen + phosphoric acid + potash. 0.600 g. nitrogen from Phil. tankage + phosphoric acid + potash.

7 8 9 13 14 15

OATS.

0.300 g. nitrogen from nitrate soda + phosphoric acid + potash. 0.300 g. nitrogen from dissolved leather + phosphoric acid + potash.

The Results.

After the product from each pot was thoroughly air dry, the grain was carefully removed, weighed, coarsely ground, and dry-matter determinations made. The straw was cut into short lengths, and together with the chaff tested for dry matter. Finally, both grain and straw were ground fine, and nitrogen determinations made.

Table I.

FORM OF NITROGEN.	Quantity of Nitrogen added to Each Pot (Grams).	Dry Matter yielded by Single Pots.		Average Dry Matter from Three Pots.		Gain in Dry Matter over Soil Nitrogen Pots, on Basis of .30 Gram of Nitrogen applied.		If Gain in Dry Matter with Nitrate Soda equal 100, then other Sources of Nitrogen would be equal to —		Average of Straw and Grain.
		Straw (Grams).	Grain (Grams).	Straw (Grams).	Grain (Grams).	Straw (Grams).	Grain (Grams).	Straw.	Grain.	
Soil nitrogen,	.00 .00 .00	7.777 7.683 8.013	1.893 1.598 1.569	7.82	1.69	-	-	.00	.00	-
Philadelphia tankage,	.60 .60 .60	9.524 8.447 8.684	1.171 .899 2.906	8.88	1.66	.53	±	5.40	±	2.70
Nitrate of soda,	.30 .30 .30	16.624 18.126 18.021	6.155 6.969 5.986	17.59	6.37	9.77	4.68	100	100	100
Dissolved leather,	.30 .30 .30	15.245 14.454 13.362	4.348 4.663 3.728	14.35	4.25	6.53	2.56	66.8	54.7	60.7
Nitrate of soda,	.60 .60 .60	19.521 20.275 18.813	2.197 1.682 1.679	19.54	1.85	-	-	-	-	-
Dissolved leather,	.60 .60 .60	19.933 18.723 20.623	4.350 5.223 5.197	19.76	4.92	-	-	-	-	-

Comments on Table I.

The first four columns in the table show the weight of straw and grain (dry matter) produced by each pot, and the average from each three pots. The next three columns indicate the gain in dry matter over those pots containing only soil nitrogen. Then follow the comparative yields, nitrate of soda being rated at 100. When the average of both straw and grain is considered, it will be seen that the dissolved leather yielded 60.7 per cent. as much as the same quantity of nitrogen in the form of nitrate of soda. The Philadelphia tankage, on the other hand, gave but a slight increase over the no-nitrogen pots; this slight gain was in the yield of straw.

In case of the last six pots, where .60 gram of nitrogen was applied in the forms of nitrate of soda and dissolved leather, we find a large amount of straw produced, but very little grain. This, in all probability, can be attributed to two causes: in the first place, in case of the nitrate of soda, one-half the quantity was not applied till early June, and this application might have been too late to enable the plants to take it up and work it over into grain; in the second place, there might not have been phosphoric acid and potash enough present to have enabled the plants to turn the nitrogen to account. Twice as much phosphoric acid and four times as much potassium oxide as nitrogen were applied; the coming year these amounts will be doubled, in order to make sure that a sufficient quantity is present. The results from these latter pots, therefore, are simply stated, but not further considered.

Table II.

FORM OF NITROGEN.	Quantity Nitrogen to Each Pot (Grams).	Nitrogen in Total Dry Matter produced (Grams).	NITROGEN IN 100 GRAMS DRY MATTER (GRAMS).		For Every 100 Parts of Nitrogen applied, there has been returned in Straw and Grain —	When Nitrate Soda equals 100, Other Sources of Nitrogen equal to —	EVERY GRAM OF NITROGEN APPLIED HAS PRODUCED IN DRY MATTER —			For Every 100 Parts of Straw, there has been produced in Grain —
			Straw.	Grain.	(Parts.)		Straw (Grams).	Grain (Grams).	Straw and Grain (Grams).	
Soil nitrogen,	.00	.0945	.68	2.604	-	-	-	-	-	21.60
Nitrate of soda,	.30	.3050	.78	2.716	70	100	32.57	15.60	48.17	36.20
Dissolved leather,	.30	.2100	.68	2.660	39	56	21.77	8.53	30.30	29.60
Philadelphia tankage,	.60	.1260	.96	2.510	5.3	7.6	.88	-	.88	18.69
Nitrate of soda,	.60	.4250	-	-	55	-	-	-	-	-
Dissolved leather,	.60	.3250	-	-	39	56	-	-	-	-

Comments on Table II.

The first two columns show the sources of nitrogen and the quantity applied to each pot. The third column shows the total average nitrogen found in the dry matter produced by each pot. Where no nitrogen was applied, the soil yielded of itself .0945 gram, and the excess over this amount obtained in the other series represents the amount that the plants succeeded in getting from the nitrogen applied. The next column shows that for every 100 parts of nitrogen applied in the form of nitrate of soda 70 parts were obtained in the grain and straw; the other 30 parts would probably largely if not entirely be found in the roots. For every 100 parts of nitrogen applied in the form of dissolved leather 39 parts were returned, while for every 100 parts applied in the form of Philadelphia tankage but 5.3 parts were recovered. The next column shows that, if the amount of nitrogen returned in case of the nitrate of soda pots be represented by 100, then the amount returned in case of dissolved leather would be 56, and in case of Philadelphia tankage 7.6. The last column indicates the parts of grain produced for every 100 parts of straw. Notice that where no nitrogen was applied only 21.6 parts of grain were produced to 100 parts of straw; but when .30 gram of nitrogen in form of nitrate of soda was added, 36 parts of grain were obtained to 100 parts of straw.

Résumé. — Action of Sulphuric Acid on Leather.

Artificial digestion tests show that nitrogen in either raw, steamed or roasted leather, after being acted on by 50° B. sulphuric acid, has a digestibility of 70 per cent. This test would class it, as regards availability, with the average quality of animal matter sold for fertilizing purposes.

The result of our first year's test with pot experiments indicates that, when nitrate of soda as a source of nitrogen is rated at 100, the nitrogen in the form of dissolved leather would be rated at about 60. The return from the Philadelphia tankage was very slight. The experiment will be continued the coming year.

12. Report on General Farm Work (1894).

The lands assigned for the use of the Massachusetts State Agricultural Experiment Station cover an area of fifty acres. Ten acres are natural woodlands, and forty acres, including the space occupied by the buildings, are used for the raising of farm crops. At present from fifteen to sixteen acres are under cultivation, and from sixteen to seventeen acres are permanent grass lands. As every portion of the land is at present serving for some special experiment, the general management of the farm is to a controlling degree subjected to the requirements of the work called for in connection with the various questions under investigation. The adoption of a thorough mechanical preparation of the soil, supported by a careful, clean cultivation of the crops raised, has brought the lands into a fair condition for field experiments. Each field has had for years its own system of manuring, and becomes thereby from year to year more valuable for experimental purposes. Wherever circumstances have been favorable, forage crops have been chosen, for the purpose of studying the influence of various systems of fertilization and cultivation on their growth and special character. This practice has resulted already in the successful introduction of some valuable forage plants new to our locality, and has also materially assisted us in an economical support of quite extensive experiments in stock feeding. The beneficial effect of many of these crops on the physical and chemical condition of our cultivated lands is everywhere noticed, when compared with their previous general condition.

During the past season soja bean, vetch and oats, vetch and barley, and vetch, oats and horse bean have been raised. The vetch and oats was fed in part green and the remainder was converted into hay for dairy cows. The soja bean was used in a mixed silage with corn. The vetch and barley and vetch, oats and horse bean were used for hay.

Twenty-six tons of corn have been put into the silos, about three to four tons being in the form of mixed silage with soja bean. Of the remainder, part was fed green and the rest harvested at maturity.

During the past season the area of the orchard has been laid down in permanent grass land. From three to four feet space around each tree has been left open for cultivation.

The amount and character of farm and garden crops raised in 1894 may be seen from the following statement: —

	Tons.
Hay (first cut),	33
Rowen,	$6\frac{1}{2}$
Potatoes,	$6\frac{1}{2}$
Oats (756 pounds grain, 2,224 pounds straw),	$1\frac{1}{2}$
Vetch and oats (hay),	$3\frac{3}{4}$
Vetch and oats (green),	$3\frac{1}{2}$
Vetch and barley (hay),	$\frac{9}{10}$
Vetch, oats and horse bean (hay),	$\frac{1}{2}$
Fodder corn (green),	29
Soja bean (green),	$3\frac{1}{8}$
Hungarian grass (green),	$2\frac{1}{5}$
Barley (657 pounds grain, 1,378 pounds straw),	1
Rye (2,576 pounds grain, 11,072 pounds straw),	$6\frac{3}{4}$
Tomatoes,	$2\frac{1}{4}$
Onions,	$\frac{7}{10}$
Carrots,	$2\frac{1}{4}$
Globe mangolds,	$1\frac{9}{10}$
Spinach,	$\frac{1}{2}$
Lettuce,	$\frac{1}{5}$
Miscellaneous,	3
	$109\frac{1}{6}$

PART III.

SPECIAL WORK IN THE CHEMICAL LABORATORY.

C. A. GOESSMANN.

I. COMMUNICATION ON COMMERCIAL FERTILIZERS: —

1. GENERAL INTRODUCTION.
2. STATE LAWS FOR THE REGULATION OF TRADE IN COMMERCIAL FERTILIZERS.
3. LIST OF LICENSED MANUFACTURERS AND DEALERS FROM MAY 1, 1894, TO MAY 1, 1895 (58).
4. ANALYSES OF LICENSED FERTILIZERS (253) (COMPILED BY H. D. HASKINS).
5. ANALYSES OF COMMERCIAL FERTILIZERS AND MANURIAL SUBSTANCES SENT ON FOR EXAMINATION (145) (COMPILED BY C. S. CROCKER).
6. MISCELLANEOUS ANALYSES (4) (COMPILED BY C. S. CROCKER).
7. MISCELLANEOUS FODDER ANALYSES (69) (COMPILED BY C. S. CROCKER).

II. ANALYSES OF MILK SENT ON FOR EXAMINATION (40) (COMPILED BY C. S. CROCKER).

III. ANALYSES OF WATER SENT ON FOR EXAMINATION (200) (COMPILED BY R. H. SMITH).

IV. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF AGRICULTURAL CHEMICALS AND REFUSE MATERIALS USED FOR FERTILIZING PURPOSES (COMPILED BY C. S. CROCKER).

V. COMPILATION OF ANALYSES MADE AT AMHERST, MASS., OF FODDER ARTICLES, FRUITS, SUGAR-PRODUCING PLANTS, DAIRY PRODUCTS, ETC. (COMPILED BY C. S. CROCKER).

VI. TABLE OF THE DIGESTIBILITY OF AMERICAN FEEDING STUFFS (COMPILED BY J. B. LINDSEY): —

A. EXPERIMENTS WITH RUMINANTS.
B. EXPERIMENTS WITH SWINE.

I.

COMMUNICATION ON COMMERCIAL FERTILIZERS.

1. General introduction.
2. State laws for the regulation of trade in commercial fertilizers.
3. List of licensed manufacturers and dealers from May 1, 1894, to May 1, 1895.
4. Analyses of licensed fertilizers.
5. Analyses of commercial fertilizers and manurial substances sent on for examination.
6. Miscellaneous analyses.
7. Miscellaneous fodder analyses.

1. General Introduction.

Fifty-eight manufacturers and dealers have applied for and received licenses for the sale of their various brands of fertilizers in our State. Twenty-five of them are residents of other States.

Two hundred and seventy-four samples of licensed articles have been collected in all parts of the State by an authorized agent of the station.* Two hundred and fifty-three of them have been carefully analyzed at the chemical laboratory of the station, with the following results: four samples contained all three essential constituents above the highest guarantee; twenty-five contained two of the essential elements above the highest guarantee; seventy contained one essential element above the highest guarantee; thirty-four contained three essential elements above the lowest guarantee; seventy-four contained two essential elements above the lowest guarantee; eighty-seven contained one element above the lowest guarantee; one contained three essential elements below the lowest stated guarantee; seventeen contained two essential elements below the lowest stated guarantee; seventy-six contained one element below the lowest

* Mr. H. D. Haskins, a graduate of the Massachusetts Agricultural College, of the class of '90, and for four years past an assistant in the chemical laboratory of the Massachusetts State Experiment Station.

stated guarantee. The deficiency in one or two essential constituents was in the majority of instances compensated for by an excess in the others.

The variations in the market price of prominent fertilizer constituents have been, on the whole, during the past year within the usual limits. Potash in its different forms, as well as nitrogen, has advanced in price compared with last year's quotations, while phosphoric acid has remained about the same.

The duties assigned to the director of the station, to act as inspector of commercial fertilizers, render it necessary to *discriminate*, in official publications of the results of analyses of commercial fertilizers and of manurial substances in general made at the station, *between analyses of samples collected by a duly qualified delegate of the experiment station, in conformity with the rules prescribed by the new laws, and those analyses which are made of samples sent on for that purpose by outside parties.* In regard to the former alone can the director assume the responsibility of a carefully prepared sample, and of the identity of the article in question.

The official report of analyses of compound fertilizers and of all such materials as are to be used for manurial purposes, which are sold in this State under a certificate of compliance with the present laws for the regulation of the trade in these articles, has been restricted by our State laws to a statement of chemical composition and to such additional information as relates to the latter.

The practice of affixing to each analysis of this class of fertilizers an approximate commercial valuation per ton of their principal constituents has, therefore, been discontinued. This change, it is expected, will tend to direct the attention of the consumers of fertilizers more forcibly towards a *consideration of the particular composition of the different brands of fertilizers offered for their patronage, a circumstance not infrequently overlooked.*

The *approximate market value* of the different brands of fertilizers obtained by the current mode of valuation does not express *their respective agricultural value, i. e.*, their crop-producing value; for the higher or lower market price

of different brands of fertilizers does not necessarily stand in a direct relation to their particular fitness, without any reference to the particular condition of the soil to be treated and the special wants of the crops to be raised by their assistance.

To select judiciously from among the various brands of fertilizers offered for patronage requires, in the main, two kinds of information, namely, we ought to feel confident that the particular brand of fertilizer in question actually contains the guaranteed quantities and qualities of essential articles of plant food at a reasonable cost, and that it contains them in such form and such proportions as will best meet existing circumstances and special wants. In some cases it may be mainly either phosphoric acid or nitrogen or potash; in others, two of them; and in others again, all three. A remunerative use of commercial fertilizers can only be secured by attending carefully to the above-stated considerations.

To assist farmers not yet familiar with the current mode of determining the commercial value of manurial substances offered for sale in our markets, some of the essential considerations, which serve as a basis for their commercial valuation, are once more stated within a few subsequent pages.

The hitherto customary valuation of manurial substances is based on the average trade value of the essential fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers depends, in the majority of cases, on the amount and the particular form of two or three essential articles of plant food, *i. e.*, phosphoric acid, nitrogen and potash, which they contain. To ascertain by this mode of valuation the approximate market value of a fertilizer (*i. e.*, the money worth of its essential fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound; the same course is adopted with reference to the various forms of phosphoric acid and of potassium oxide. We thus get the values per ton of the several ingredients, and, adding them together,

we obtain the total valuation per ton in case of cash payment at points of general distribution.

The market value of low-priced materials used for manurial purposes, as salt, wood ashes, various kinds of lime, barn-yard manure, factory refuse and waste materials of different description, quite frequently does not stand in a close relation to the market value of the amount of essential articles of plant food they contain. Their cost varies in different localities. Local facilities for cheap transportation, and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value in case of one and the same kind of substance. Two samples of fish fertilizers, although equally pure, may differ from fifty to one hundred per cent. in commercial value on account of mere difference in moisture.

Crude stock for the manufacture of fertilizers, and refuse materials of various descriptions, have to be valued with reference to the market price of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals, 1894.

	Cents per Pound.
Nitrogen in ammonia salts,	19
Nitrogen in nitrates,	14½
Organic nitrogen in dry and fine-ground fish, meat, blood, and in high-grade mixed fertilizers,	18½
Organic nitrogen in cotton-seed meal, linseed meal and castor pomace,	15
Organic nitrogen in fine-ground bone and tankage,	16½
Organic nitrogen in fine-ground medium bone and tankage,	15

Trade Values of Fertilizing Ingredients, etc. — Concluded.

	Cents per Pound.
Organic nitrogen in medium bone and tankage, . .	12
Organic nitrogen in coarse bone and tankage, . .	7
Organic nitrogen in hair, horn shavings and coarse fish scraps, ...	7
Phosphoric acid soluble in water, ...	6
Phosphoric acid soluble in ammonium citrate, . .	$5\frac{1}{2}$
Phosphoric acid in fine bone and tankage, . . .	$5\frac{1}{2}$
Phosphoric acid in fine medium bone and tankage, .	$4\frac{1}{2}$
Phosphoric acid in medium bone and tankage, . .	3
Phosphoric acid in coarse bone and tankage, . . .	2
Phosphoric acid in fine-ground fish, cotton-seed meal, linseed meal, castor pomace and wood ashes, . .	5
Phosphoric acid insoluble (in ammonium citrate) in mixed fertilizers, ...	2
Potash as high-grade sulphate, and in mixtures free from muriate, ...	$5\frac{1}{4}$
Potash as muriate, ...	$4\frac{1}{2}$

The manurial constituents contained in feed stuffs are valued as follows: —

	Cents per Pound.
Organic nitrogen, ...	15
Phosphoric acid, ...	5
Potash, ...	5

The organic nitrogen in *superphosphates, special manures and mixed fertilizers of a high grade* is usually valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, fifteen and a half cents per pound; it being assumed that the organic nitrogen is derived from the best sources, viz., animal matter, as meat, blood, bones or other equally good forms, and not from leather, shoddy, hair or any low-priced, inferior form of vegetable matter, unless the contrary is ascertained. The insoluble phosphoric acid is valued in this connection at two cents.

The above trade values are the figures at which, in the six months preceding March, 1894, the respective ingredients could be bought at *retail for cash in our large markets, in the raw materials*, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus about twenty per cent.

in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to agree fairly with the retail price at the large markets of standard raw materials, such as : —

Sulphate of ammonia,	Dry ground fish,
Nitrate of soda,	Azotin,
Muriate of potash,	Ammonite,
Sulphate of potash,	Castor pomace,
Dried blood,	Bone and tankage,
Dried ground meat,	Plain superphosphates.

A large percentage of commercial materials consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. To assist the farming community in a clear and intelligent appreciation of the various substances sold for manurial purposes, a frequent examination into the temporary characters of agricultural chemicals and refuse materials offered in our markets for manurial purposes is constantly carried on at the laboratory of the station.

Consumers of commercial manurial substances do well to buy, whenever practicable, on guarantee of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Our present laws for the regulation of the trade in commercial fertilizers include not only the various brands of compound fertilizers, but also all materials, single or compound, without reference to source, used for manurial purposes when offered for sale in our market at ten dollars or more per ton. Copies of our present laws for the regulation of the trade in commercial fertilizers may be had by all interested, on application at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

2. The Provisions of the Act are as follows:

[Chapter 296.]

An Act to regulate the sale of commercial fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or material used for manurial purposes sold, offered or exposed for sale within this Commonwealth, the retail price of which is ten dollars or more per ton, shall be accompanied by a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the place of manufacture, and a chemical analysis stating the percentage of nitrogen or its equivalent in ammonia, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials, said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer, the retail price of which is ten dollars or more per ton, is sold, offered or exposed for sale, the importer, manufacturer or party who causes it to be sold or offered for sale within the state of Massachusetts, shall file with the director of the Massachusetts agricultural experiment station, a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Sect. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or material used for manurial purposes, the retail price of which is ten dollars or more per ton, shall pay for each brand, on or before the first day of May annually, to the director of the Massachusetts agricultural experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand or fertilizer: *provided*, that whenever the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of

said analysis fees and statement specified in section two, the director of said station shall issue certificates of compliance with this act.

Sect. 4. No person shall sell, offer or expose for sale in the state of Massachusetts, any pulverized leather, raw, steamed, roasted, or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure and to accompany or go with every parcel or lot of the same.

Sect. 5. Any person selling, offering or exposing for sale, any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence, and one hundred dollars for each subsequent offence.

Sect. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use, and not to sell in this state.

Sect. 7. The director of the Massachusetts agricultural experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or material used for manurial purposes to be made annually, and publish the results monthly, with such additional information as circumstances advise: *provided*, such information relates only to the composition of the fertilizer or fertilizing material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or any material used for manurial purposes which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was drawn and the time and place of drawing, and said label shall also be signed by the director or his deputy and by the party or parties in interest or their representatives present at the drawing and sealing of said sample; one of

said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station; but it shall be the duty of said director, upon ascertaining any violation of this act, to forthwith notify the manufacturer or importer in writing, and give him not less than thirty days thereafter in which to comply with the requirements of this act, but there shall be no prosecution in relation to the quality of the fertilizer or fertilizing material if the same shall be found substantially equivalent to the statement of analysis made by the manufacturer or importer.

SECT. 8. Sections eleven to sixteen inclusive of chapter sixty of the Public Statutes are hereby repealed.

SECT. 9. This act shall take effect on the first day of September in the year eighteen hundred and eighty-eight. [*Approved May 3, 1888.*]

Instructions to Manufacturers, Importers, Agents and Sellers of Commercial Fertilizers or Materials used for Manurial Purposes in Massachusetts.

1. An application for a certificate of compliance with the regulations of the trade in commercial fertilizers and materials used for manurial purposes in this State must be accompanied: —

First, with a distinct statement of the name of each brand offered for sale.

Second, with a statement of the amount of phosphoric acid, of nitrogen and of potassium oxide guaranteed in each distinct brand.

Third, with the fee charged by the State for a certificate, which is five dollars for each of the following articles, nitrogen, phosphoric acid and potassium oxide, guaranteed in any distinct brand.

2. The obligation to secure a certificate applies not only to compound fertilizers but to all substances, single or compound, used for manurial purposes, and offered for sale at ten dollars or more per ton of two thousand pounds.

3. The certificate must be secured annually before the first of May.

4. Manufacturers, importers and dealers in commercial fertilizers can appoint in this State as many agents as they

desire, after having secured at this office the certificate of compliance with our laws.

5. Agents of manufacturers, importers and dealers in commercial fertilizers are held personally responsible for their transactions until they can prove that the articles they offer for sale are duly recorded in this office.

6. Manufacturers and importers are requested to furnish a list of their agents.

7. All applications for certificates should be addressed to the Director of the Massachusetts State Agricultural Experiment Station.

Arrangements are made, as in previous years, to attend to the examination of objects of general interest to the farming community, to the full extent of existing resources. Requests for analyses of substances — as fodder articles, fertilizers, etc. — coming through officers of agricultural societies and farmers' clubs within the State will receive hereafter, as in the past, first attention, and in the order that the applications arrive at the office of the station. The results will be returned without a charge for the services rendered. Application of private parties for analyses of substances, free of charge, will receive a careful consideration whenever the results promise to be of a more general interest. For obvious reasons, no work can be carried on at the station of which the results are not at the disposal of the managers for publication, if deemed advisable in the interest of the citizens of the State.

All parcels and communications sent to "The Massachusetts State Experiment Station" must have express and postal charges prepaid, to receive attention.

3. List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year (May 1, 1894, to May 1, 1895), and the Brands licensed by Each.

Allison, Stroup & Co., New York, N. Y.: —
- Odorless Phosphate.
- Canada Wood Ashes.

Ames Fertilizer Company, Peabody, Mass.: —
- Plymouth Rock Brand.
- Special Potato Fertilizer.
- Strawberry Fertilizer.
- Ground Bone.
- Nitrate of Soda.
- Sulphate of Potash.
- Muriate of Potash.

H. J. Baker & Bro., New York, N. Y.: —
- Special Potato Manure.
- Special Grass Manure.
- "A A" Ammoniated Superphosphate.
- Special Tobacco Manure.
- Special Corn Manure.
- Standard A X C D Fertilizer.
- Special Strawberry Manure.
- Pure Ground Bone.
- Nitrate of Soda.
- Muriate of Potash.

C. A. Bartlett, Worcester, Mass.: —
- Pure Ground Bone.
- Animal Fertilizer.

J. L. Bonzey, Auburn, Mass.: —
- Ground Bone.

Bowker Fertilizer Company, Boston, Mass.: —
- Stockbridge Special Manures.
- Bowker's Hill and Drill Phosphate.
- Bowker's Farm and Garden Phosphate.
- Bowker's Lawn and Garden Dressing.
- Bowker's Fish and Potash.

Bowker Fertilizer Company, Boston, Mass. — *Concluded.*
- Bowker's Potato and Vegetable Manure.
- Bowker's Sure Crop Bone Phosphate.
- Gloucester Fish and Potash.
- Bowker's Dried Ground Fish.
- Bowker's Fresh Ground Fish.
- Nitrate of Soda.
- Dried Blood.
- Dissolved Bone-black.
- Muriate of Potash.
- Sulphate of Potash.

Bradley Fertilizer Company, Boston, Mass. : —
- X L Phosphate.
- Potato Manure.
- B D Sea Fowl Guano.
- Complete Manures.
- Fish and Potash.
- High-grade Tobacco Manure.
- English Lawn Fertilizer.
- Breck's Lawn and Garden Dressing.
- Circle Brand Bone and Potash.
- Eclipse Phosphate.
- Fine-ground Bone.
- Dissolved Bone-black.
- Sulphate of Ammonia.
- Nitrate of Soda.
- Muriate of Potash.
- Sulphate of Potash.

W. J. Brightman & Co., Tiverton, R. I. : —
- High-grade Potato and Root Manure.
- Superphosphate.
- Fish and Potash.
- Menhaden Fish Guano.

Bryant & Brett, New Bedford, Mass. : —
- Ground Bone.

Joseph Church & Co., Tiverton, R. I. : —
- Church's Fish and Potash.
- Church's " B " Special Fertilizer.
- Church's " C " Standard Fertilizer.

Clark's Cove Fertilizer Company, Boston, Mass.: —
- Bay State Fertilizer.
- Bay State Fertilizer, "G G."
- King Philip Guano.
- Potato and Tobacco.
- Great Planet "A."
- Bay State Potato Manure.
- Tobacco Fertilizer.
- Fish and Potash.
- White Oak Pure Ground Bone.
- Muriate of Potash.
- Sulphate of Potash.
- Nitrate of Soda.

Cleveland Dryer Company, Boston, Mass.: —
- Corn and Grain Phosphate.
- Cleveland Fertilizer.
- Cleveland Potato Phosphate.
- Cleveland Superphosphate.

Cleveland Linseed Oil Company, Cleveland, O.: —
- Connecticut Wrapper Fertilizer.
- Coarse Linseed Meal.

E. Frank Coe Company, New York, N. Y.: —
- Alkaline Bone.
- High-grade Ammoniated Bone Superphosphate.
- Red Brand Excelsior.
- Gold Brand Excelsior.
- Special Tobacco Fertilizer.
- High-grade Potato Fertilizer.
- Fish and Potash.
- Special Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y.: —
- Ammoniated Bone Superphosphate.
- Potato, Hop and Tobacco Phosphate.
- Special Potato Manure.
- Pure Ground Bone.
- Ammoniated Practical Superphosphate.
- Vegetable Bone Superphosphate.
- New Rival Ammoniated Superphosphate.
- Ammoniated Wheat and Corn Phosphate.
- Lawn Fertilizer.
- Ground Bone Meal.

Cumberland Bone Phosphate Company, Boston, Mass. : —
- Concentrated Phosphate.
- Cumberland Fertilizer.
- Potato Phosphate.
- Superphosphate.

L. B. Darling Fertilizer Company, Pawtucket, R. I. : —
- Animal Fertilizer.
- Extra Bone Phosphate.
- Potato and Root Crop Manure.
- Lawn and Garden Manure.
- Tobacco Grower.
- Pure Fine Bone.
- Pure Dissolved Bone.

Davidge Manufacturing Company, New York, N. Y. : —
- Special Favorite.
- Wheat and Corn Phosphate.
- Tobacco Fertilizer.
- Vegetator.

John C. Dow & Co., Boston, Mass. : —
- Dow's Nitrogenous Superphosphate.
- Dow's Ground Bone Fertilizer.
- Dow's Ground Bone.

Forest City Wood Ash Company, Boston, Mass. : —
- Canada Unleached Wood Ashes.

Wm. E. Fyfe & Co., Clinton, Mass. : —
- Wood Ashes (Star Brand).

Great Eastern Fertilizer Company, Rutland, Vt. : —
- Great Eastern General for Grain and Grass.
- Great Eastern Vegetable, Vine and Tobacco.
- Great Eastern General, Oats, Buckwheat and Seeding-down.
- Great Eastern Soluble Bone and Potash Fertilizer.

Hargraves Manufacturing Company, Fall River, Mass. : —
- Ground Bone.

Edmund Hersey, Hingham, Mass. : —
- Fine-ground Bone.

Thos. Hersom & Co., New Bedford, Mass. : —
- Bone Meal.
- Meat and Bone.

John G. Jefferds, Worcester, Mass. : —
Animal Fertilizer.
Potato Fertilizer.
Ground Bone.

Thos. Kirley, South Hadley Falls, Mass. : —
Pride of the Valley.

A. Lee & Co., Lawrence, Mass. : —
Lawrence Fertilizer.

Lowe Bros. & Co., Fitchburg, Mass. : —
Bone.

Lowell Bone Fertilizer Company, Lowell, Mass. : —
Lowell Bone Fertilizer.

The Mapes Formula and Peruvian Guano Company, New York, N. Y. : —
The Mapes Bone Manures.
Peruvian Guano.
The Mapes Superphosphates.
The Mapes Special Crop Manures.
Sulphates of Potash.
Economical Manure.
Nitrate of Soda.

Mason, Chapin & Co., Providence, R. I. : —
Odorless Chemical Compound Fertilizer.

James E. McGovern, Lawrence, Mass. : —
West Andover Market Bone Phosphate.
Ground Bone.

McQuade Bros., West Auburn, Mass. : —
Ground Bone.

Munroe, Lalor & Co., Oswego, N. Y. : —
Canada Wood Ashes.
Swift's Ground Bone.

National Fertilizer Company, Bridgeport, Conn. : —
Complete Fertilizers.
Universal Phosphate.
Fish and Potash.
Ground Bone.

Pacific Guano Company, Boston, Mass. : —
 Pacific Guano.
 Potato Manure.
 Potato and Tobacco Fertilizer.
 Fish and Potash.
 High-grade General Fertilizer.

John J. Peters, Long Island City, N. Y. : —
 Sheep Fertilizers.

Powers, Gibbs & Co. : —
 Special Potato Guano.
 X X X X X Peerless Ammoniated Guano.
 Sea Bird Ammoniated Guano.

Prentiss, Brooks & Co., Holyoke, Mass. : —
 Complete Manure.
 Phosphate.
 Nitrate of Soda.
 Muriate of Potash.
 Sulphate of Potash.
 Tankage.
 Dissolved Bone-black.

Preston Fertilizer Company, Greenpoint, L. I. : —
 Potato Fertilizer.
 Ammoniated Bone Superphosphate.

Quinnipiac Company, Boston, Mass. : —
 Quinnipiac Phosphate.
 Quinnipiac Potato Manure.
 Quinnipiac Market-garden Manure.
 Quinnipiac Fish and Potash, Crossed Fishes.
 Quinnipiac Fish and Potash, Plain Brand.
 Quinnipiac Potato and Tobacco Fertilizer.
 Quinnipiac Havana Tobacco Fertilizer.
 Quinnipiac Corn Manure.
 Quinnipiac Grass Fertilizer.
 Quinnipiac Bone Meal.
 Quinnipiac Dry Ground Fish.
 Quinnipiac Onion Manure.
 Ammoniated Dissolved Bone-black.
 Muriate of Potash.
 Sulphate of Potash.
 Sulphate of Ammonia.

Quinnipiac Company, Boston, Mass. — *Concluded.*
Nitrate of Soda.
Dissolved Bone-black.
Tankage.

Read Fertilizer Company, New York, N. Y. : —
Read's Standard.
High-grade Farmer's Friend.
Fish and Potash.
Vegetable and Vine.

John S. Reese & Co., Baltimore, Md. : —
Potato Special.
New England Favorite.
Pilgrim.

N. Roy & Son, South Attleborough, Mass. : —
Animal Fertilizer.

Lucien Sanderson, New Haven, Conn. : —
Formula "A."
Formula "B."
High-grade Sulphate of Potash.
Regular Sulphate of Potash.

Edward H. Smith, Northborough, Mass. : —
Fine-ground Bone.

Springfield Provision Company, Brightwood, Mass. : —
Blood, Meat and Bone.

Standard Fertilizer Company, Boston, Mass. : —
Complete Manure.
Standard Guano.
Potato and Tobacco Fertilizer.
Standard Fertilizer.
Standard Superphosphate.

T. L. Stetson, Randolph, Mass. : —
Fine-ground Bone.

F. C. Sturtevant, Hartford, Conn. : —
Tobacco and Sulphur Fertilizer.

Henry F. Tucker, Boston, Mass. : —
Original Bay State Bone Superphosphate.
Imperial Bone Superphosphate.
Special Potato Fertilizer.

Walker, Stratman & Co., Pittsburg, Pa.: —
- Potato Special.
- Tobacco Special.
- Banner.
- Four Fold.

M. E. Wheeler & Co., Rutland, Vt.: —
- Corn Fertilizer.
- Potato Manure.
- Grass and Oats Fertilizer.
- Electrical Dissolved Bone.

Whittemore Bros., Wayland, Mass.: —
- Whittemore's Complete Manure.

Leander Wilcox, Mystic, Conn.: —
- Potato, Onion and Tobacco Manure.
- Ammoniated Bone Superphosphate.
- High-grade Fish and Potash.
- Dry Ground Fish.

Williams & Clark, Boston, Mass.: —
- Potato Phosphate.
- Grass Manure.
- High-grade Special.
- Americus Corn Phosphate.
- Americus Potato and Tobacco Manure.
- Universal Ammoniated Dissolved Bones.
- Prolific Crop Producer.
- Americus Fish and Potash.
- Fish and Potash, No. 1.
- Royal Bone Phosphate.
- Onion Manure.
- Americus Ammoniated Bone Superphosphate.
- Dry Ground Fish.
- Pure Bone Meal.
- Tobacco Fertilizer.
- Tankage.
- Muriate of Potash.
- Sulphate of Potash.
- Nitrate of Soda.
- Sulphate of Ammonia.
- Dissolved Bone-black.
- Double Sulphate of Potash.

4. Analyses of Licensed Fertilizers collected during 1894 in the General Markets by the Agent of the Massachusetts State Agricultural Experiment Station.

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
7	Lowell Bone Fertilizer,	J. W. Butman, Lowell, Mass.,	Amherst.
15	Blood, Bone and Meat,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
17	Blood, Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
22	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
27	Complete Manure for Corn and Grain,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
29	Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
30	Complete Manure for General Use,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Worcester.
31	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Worcester.
32	Potato Manure,	J. G. Jefferds, Worcester, Mass.,	Worcester.
35	Potato Manure,	Bradley Fertilizer Company, Boston, Mass.,	Worcester.
40	X L Superphosphate,	Bradley Fertilizer Company, Boston, Mass.,	Springfield.
41	Corn Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
42	Potato Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
43	Crossed Fish and Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
53	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.

55	Vegetable, Vine and Tobacco Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Sunderland.
60	High-grade Special,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
62	Complete Tobacco Fertilizer,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
63	Chittenden's Fish and Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
67	Dry Ground Fish,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
68	Complete Corn Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
69	Ground Tankage,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
73	Complete Grass Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
76	Superphosphate,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
79	Blood, Meat and Bone,	Springfield Provision Company, Brightwood, Mass.,	Brightwood.
99	Fish and Potash,	Wm. J. Brightman & Co., Tiverton, R. I.,	Dighton.
120	Complete Manure for Corn and Grass,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
127	Animal Fertilizer,	C. A. Bartlett, Worcester, Mass.,	Boston.
141	Potato Special,	H. F. Tucker, Boston, Mass.,	Taunton.
149	Complete Tobacco Manure,	National Fertilizer Company, Bridgeport, Conn.,	Deerfield.
166	Tobacco Fertilizer,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
7	Lowell Bone Fertilizer,	10.32	2.55	2	-	7.84	.67	8.51	8	7.84	-	2.94	2
15	Blood, Bone and Meat,	11.36	8.25	6.59—8.24	.08	6.08	2.92	9.08	10—12	6.16	-	-	-
17	Blood, Bone and Meat,	6.49	4.94	5.77—7.41	.38	11.44	5.40	17.22	10—12	11.82	-	-	-
22, 41	Corn Manure,	15.65	2.42	2.06—2.88	6.24	4.87	1.79	12.90	10—14	11.11	9—12	3.18	1.50—2.50*
27, 120	Complete Manure for Corn and Grain,	9.38	3.81	3.30—4.12	3.04	8.16	4.81	16.01	13—15	11.20	12—14	2.98	3—4*
29	Potato Manure,	7.99	3.60	3.71—4.12	4.91	4.91	.67	10.49	8—10	9.82	8	8.20	6—8*
30	Complete Manure for General Use,	11.71	3.33	3.30—4.12	4.98	4.41	.90	10.29	10—12	9.39	-	5.40	4—5
31, 127	Animal Fertilizer,	6.08	2.78	3.30—4.12	3.74	8.52	1.66	13.92	13—15	12.26	-	8.26	7—8
32	Potato Manure,	9.35	2.28	2.47—3.30	4.72	6.54	2.82	14.08	15—17	11.26	10—12	5.48	5—6
35	Potato Manure,	12.82	2.82	2.5—3.25	2.81	4.00	2.20	9.01	8—11	6.81	6—8	5.12	5—6
40	X L Superphosphate,	14.23	2.77	2.50—3.25	6.52	2.76	1.80	11.08	11—14	9.28	9—11	2.08	2—3*

42	Potato Manure,	13.10	2.50	2.47—3.30	3.33	5.21	.77	9.31	7—11	8.54	6—9	7.26	5—6*
43	Crossed Fish and Potash,	16.10	3.92	3.30—4.12	4.61	1.14	1.41	7.16	5—8	5.75	3—5	5.08	3—5*
53, 67	Dry Ground Fish,	11.49	7.58	7.41—9.06	.74	5.78	1.51	8.03	7—9	6.52	-	-	-
55	Vegetable, Vine and Tobacco Fertilizer,	14.70	2.32	2.06—2.51	6.98	1.01	1.46	9.45	9—15	7.99	8—12	6.35	6—8
60	High grade Special,	12.41	3.95	3.7—4.12	5.23	2.86	1.20	9.29	8—11	8.09	7—9	7.43	7—9
62, 149	Complete Tobacco Manure,	10.28	3.41	3.30—4.94	6.19	5.37	1.23	12.79	10—12	11.56	8—10	5.48	5.40—6.48
63	Chittenden's Fish and Potash,	8.73	2.92	2.88—3.71	3.79	3.83	1.69	9.31	6—8	7.62	-	4.45	5—6
68	Complete Corn Manure,	10.52	3.24	3.30—4.12	5.17	2.71	3.94	11.82	8—10	7.88	6—8	7.33	6—8
69	Ground Tankage,	8.91	7.73	7.41—7.83	.65	5.74	1.16	7.55	8—9	6.39	-	-	-
73	Complete Grass Manure,	5.93	4.89	4.12—4.94	2.20	2.86	3.84	8.90	7—8	5.06	4—5	8.42	7—9
76	Superphosphate,	12.60	2.74	2.06—2.47	9.52	.86	3.74	14.12	10—12	10.38	8—10	2.81	2.5—3
79	Blood, Meat and Bone,	8.08	8.13	7—8	.35	5.98	1.36	7.69	9.5—10.5	6.33	-	-	-
99	Fish and Potash,	18.10	2.91	2.07—2.88	3.48	3.53	1.18	8.19	7.5—10.5	7.01	6—8	2.45	2—3
141	Potato Special,	10.27	2.78	2.40	6.75	1.80	1.79	10.34	9—13	8.55	8—11	5.40	6—7
166	Tobacco Fertilizer,	12.25	1.70	3.30—4.12	10.36	1.66	1.54	13.56	-	12.02	9—10	1.24	3.79—5.05

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
152	Fish and Potash,	Clark Cove Fertilizer Company, Boston, Mass.,	Deerfield.
170	Standard Unexcelled Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	Pittsfield.
172	Ammoniated Bone Superphosphate,	E. Frank Coe Fertilizer Company, New York, N. Y.,	Westfield.
176	High-grade Fish Guano and Potash,	E. Frank Coe Fertilizer Company, New York, N. Y.,	Westfield.
179	Potato, Hop and Tobacco Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Westfield.
182	Bay State Fertilizer,	Clark Cove Fertilizer Company, Boston, Mass.,	Greenfield.
187	Tobacco Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Greenfield.
202	Animal Fertilizer,	N. Roy & Son, North Attleborough, Mass.,	Amherst.
266	Tobacco Grower,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Sunderland.
	Chemicals.		
12	Electrical Dissolved Bone,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
14	Dissolved Bone-black,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
18	Sulphate of Potash and Magnesia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
19	Dissolved Bone-black,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
21	Sulphate of Potash and Magnesia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
36	Sulphate of Potash and Magnesia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
46	Sulphate of Ammonia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.

47	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
58	Muriate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
61	Sulphate of Potash,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
66	Sulphate of Potash,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
70	Dissolved Bone-black,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
92	Nitrate of Soda,	Bowker Fertilizer Company, Boston, Mass.,	Fall River.
145	Sulphate of Potash and Magnesia,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
146	Dissolved Bone-black,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
208	Muriate of Potash,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
	Bones.		
6	Steamed Fine Bone,	E. H. Smith, Northborough, Mass.,	Amherst.
8	Fine-ground Bone,	McQuade Bros., West Auburn, Mass ,	Amherst.
28	Steamed Fine Bone,	E. H. Smith, Northborough, Mass.,	Worcester.
77	Fine-ground Bone,	McQuade Bros., West Auburn, Mass.,	West Auburn.
90	Ground Bone,	John C. Dow & Co., Boston, Mass.,	Amherst.
214	Ground Bone,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
152	Fish and Potash,	15.00	2.81	2.06—2.88	4.35	2.66	1.38	8.39	7—11	7.01	6—8	2.43	2—3
170	Standard Unexcelled Fertilizer,	13.93	2.72	2.06—2.26	8.14	.53	1.05	9.72	-	8.67	8—10	2.82	2—3
172	Ammoniated Bone Superphosphate,	10.05	2.73	2	7.01	2.82	3.17	13.00	11—15	9.83	9—12	2.67	1.85
176	High-grade Fish Guano and Potash,	7.15	2.63	2.47—3.30	2.56	2.45	3.48	8.49	7—11	5.01	6—9	3.39	2.75*
179	Potato, Hop and Tobacco Fertilizer,	14.03	2.07	2—3	7.01	3.30	1.33	11.64	11—14	10.31	10—12	3.84	3.25—4.30
182	Bay State Fertilizer,	12.83	2.60	2.47—3.30	5.35	3.18	1.91	10.44	10—14	8.53	9—12	2.80	2—3
187	Tobacco Manure,	6.09	5.62	6.18	-	5.40	.15	5.55	4—5	5.40	-	12.34	10.5
202	Animal Fertilizer,	4.07	4.28	4.28	.13	11.54	.28	11.95	11.95	11.67	-	-	-
266	Tobacco Grower,	8.89	4.22	4.94—5.77	.97	4.71	1.33	7.01	10—12	5.68	-	9.73	10.80
	Chemicals.												
12	Electrical Dissolved Bone,	13.95	-	-	7.82	5.06	.58	13.46	15—20	12.88	13—17	-	-
14	Dissolved Bone-black,	12.63	-	-	12.84	2.51	.77	16.12	16—18	15.35	-	-	-
18, 36	Sulphate of Potash and Magnesia,	3.54	-	-	-	-	-	-	-	-	-	27.16	27.02—29.72
19	Dissolved Bone-black,	13.36	-	-	16.88	-	-	16.88	16—18	16.88	16.18	-	-

21	Sulphate of Potash and Magnesia,	3.95	-	-	-	-	-	-	-	-	-	29.44		27.02—29.72	
46	Sulphate of Ammonia,	.73	20.55	19.78—20.60	-	-	-	-	-	-	-	-		-	
47, 92	Nitrate of Soda,	1.00	15.79	15.64—15.97	-	-	-	-	-	-	-	-		-	
58	Muriate of Potash,	1.34	-	-	-	-	-	-	-	-	-	50.44		50.54—53.70	
61	Sulphate of Potash,	1.10	-	-	-	-	-	-	-	-	-	49.92		-	
66	Sulphate of Potash,	.75	-	-	-	-	-	-	-	-	-	48.16		48.64—51.34	
70	Dissolved Bone-black,	12.16	-	-	15.51	-	2.00	17.50	16—17	15.51	16	-		-	
145	Sulphate of Potash and Magnesia,	5.89	-	-	-	-	-	-	-	-	-	25.80		25.94—28.10	
146	Dissolved Bone-black,	15.97	-	-	15.81	.44	.36	16.61	-	16.25	15—16	-		-	
208	Muriate of Potash,	1.42	-	-	-	-	-	-	-	-	-	50.04		50.54—53.70	
												Mechanical Analysis.			
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.
6, 28	Steamed Fine Bone,	4.91	4.09	4.02	.30	18.63	2.93	21.86	23	18.93	7.69	23.80	47.32	28.88	-
8, 77	Fine-ground Bone,	3.29	2.73	2.78	.05	22.82	1.64	24.51	24.52	22.87	16.74	47.07	23.63	18.00	11.30
90	Ground Bone,	2.14	1.65	1.65—2.47	.20	25.84	2.05	28.09	24—26	26.04	-	60.67	39.33	-	-
214	Ground Bone,	6.08	3.98	2.90—3.70	.26	16.32	8.67	25.25	25	16.58	-	43.87	25.66	22.60	7.87

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
3	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
9	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
20	Pulverized Bone and Meat,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
37	Ammoniated Bone Superphosphate, "Americus,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Springfield.
38	Quinnipiac Phosphate,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
65	Ammoniated Bone Superphosphate,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
81	Hill and Drill Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
82	Lawn and Garden Dressing,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
85	Potato and Vegetable,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
89	Ground Bone Fertilizer,	John C. Dow & Co., Boston, Mass.,	Amherst.
93	Corn Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Bridgewater.
94	Wood Ashes,	Forest City Wood Ash Company, London, Ont.,	Boston.
95	Special Potato Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
97	Potato and Root Crop Manure,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Somerset.
98	Potato Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
104	Animal Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Bridgewater.
105	Standard Fertilizer,	Standard Fertilizer Company, Boston, Mass.,	Whitman.

106	Vegetable, Vine and Fruit,	Read Fertilizer Company, Syracuse, N. Y.,	Bridgewater.
110	Pure Dry Ground Fish,	Joseph Church & Co., Tiverton, R. I.,	Dighton.
111	English Lawn Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Whitman.
113	Fish and Potash, "B Brand,"	Bradley Fertilizer Company, Boston, Mass.,	Bridgewater.
114	Brightman's Phosphate,	Wm. J. Brightman & Co., Tiverton, R. I.,	West Bridgewater.
161	Potato Fertilizer,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
164	Potato Fertilizer,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
190	Ammoniated Bone Superphosphate, "Americus,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
261	Banner Fertilizer,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
	Chemicals.		
45	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
56	Dissolved Bone-black,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
107	Dissolved Bone-black,	Bowker Fertilizer Company, Boston, Mass.,	Fall River.
108	Nitrate of Soda,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
201	Dissolved Bone-black,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
220	Dissolved Bone-black,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
3, 261	Banner Fertilizer,	9.62	2.65	2.06—2.88	5.32	2.13	2.00	9.45	11—12	7.45	9—10	1.62	1—2*
9, 93	Corn Fertilizer,	13.65	2.88	1.65—2.47	4.64	3.22	1.64	9.50	9—14	7.86	8—12	2.45	1.65—2.47*
20	Pulverized Bone and Meat,	7.29	5.21	5.77—6.59	.30	11.99	5.58	17.87	18—20	12.29	-	-	-
37, 190	Ammoniated Bone Superphosphate, "Americus,"	13.88	2.63	2.47—3.30	6.26	2.82	2.18	11.26	10—13	9.08	9—11	2.70	2—3
38	Quinnipiac Phosphate,	15.13	2.92	2.47—3.30	6.00	3.47	.84	10.31	10—14	9.47	9—12	2.73	2—3*
65	Ammoniated Bone Superphosphate,	14.82	2.48	1.65—2.06	.82	7.60	2.51	10.93	9—11	8.42	7—9	3.25	2—4
81	Hill and Drill Phosphate,	13.53	2.80	2.50—3.50	5.22	4.04	3.23	12.54	12—13	9.26	9—11	2.35	2—3
82	Lawn and Garden Dressing,	9.32	4.86	3.25—4.25	5.63	1.95	3.17	10.75	8—10	7.58	6—8	5.54	5—6
85	Potato and Vegetable,	12.20	3.28	3.25—4.25	6.14	2.82	1.89	10.85	8—10	8.96	6—8	6.92	7—8
89	Ground Bone Fertilizer,	6.66	2.20	2.06—2.47	.87	14.74	4.50	20.11	18—22	15.61	-	3.51	1.62—1.89
94	Wood Ashes,	11.59	-	-	-	-	-	1.13	1.5—2.5	-	-	5.28	4.5—8
95	Special Potato Fertilizer,	9.73	3.00	3—4	4.61	5.13	.79	10.53	9—13	9.74	8—11	9.00	7—9

97	Potato and Root Crop Manure,	9.43	2.76	2.88—4.12	3.48	6.24	1.74	11.46	10—12	9.72	6—8	6.57	7—9
98	Potato Manure,	10.99	4.01	3.30	4.52	1.77	.54	6.83	5.75	6.29	-	10.64	10
104	Animal Fertilizer,	13.21	3.06	3—4.5	3.89	4.25	.92	9.06	10—12	8.14	6—8	3.58	4—6
105	Standard Fertilizer,	15.07	2.20	2—3	5.76	2.56	2.30	10.62	10—15	8.32	8—12	2.18	2—3
106	Vegetable, Vine and Fruit,	12.01	1.84	1.65—2.47	4.55	3.13	.46	8.14	7—9	7.68	6—8	7.54	8—10
110	Pure Dry Ground Fish,	7.89	9.62	9.06—9.89	.10	6.70	1.69	8.49	6.87—9.16	6.80	-	-	-
111	English Lawn Dressing,	9.75	3.87	4.95—5.78	1.28	5.42	1.33	8.03	6—8	6.70	5—7	2.08	2.5—3.5
113	Fish and Potash, "B Brand,"	17.80	2.58	2.06—2.88	4.35	1.12	2.46	7.93	7.5—10.5	5.47	6—8	2.70	2—3
114	Brightman's Phosphate,	12.75	2.50	2.5—3.25	3.99	3.02	.67	7.68	8—11	6.01	6—8	5.72	5—6
161, 164	Potato Fertilizer,	15.08	1.10	3.30—4.12	5.73	4.14	1.13	11.00	-	9.87	8—9	7.46	7—9
	Chemicals.												
45, 107	Dissolved Bone-black,	13.75	-	-	14.67	.45	.33	15.45	18	15.12	15—18	-	-
56	Dissolved Bone black,	12.52	-	-	12.13	3.12	.26	15.51	15—18	15.25	-	-	-
108	Nitrate of Soda,	1.50	15.02	15.5—16.5	-	-	-	-	-	-	-	-	-
201	Dissolved Bone black,	10.99	-	-	11.90	3.86	.26	16.02	15—18	15.76	-	-	-
220	Dissolved Bone-black,	13.34	-	-	13.15	2.48	.64	16.27	15—18	15.63	-	-	-

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
140	Cleveland Superphosphate,	Cleveland Dryer Company, Boston, Mass.,	SouthFramingham.
151	Dry Ground Fish,	Quinnipiac Fertilizer Company, Boston, Mass.,	South Deerfield.
155	Ammoniated Bone Superphosphate,	Preston Fertilizer Company, Greenpoint, L. I.,	Pittsfield.
160	Ammoniated Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
165	Fine-ground Bone and Potash, "Circle Brand,"	Bradley Fertilizer Company, Boston, Mass.,	Pittsfield.
171	Special Potato Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Westfield.
174	Ammoniated Bone Superphosphate,	Preston Fertilizer Company, Greenpoint, L. I.,	Lanesborough.
178	High-grade Tobacco Manure,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
181	Potato Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
186	Complete Tobacco Fertilizer,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
198	Cumberland Superphosphate,	Cumberland Bone Phosphate Company, Portland, Me.,	Hudson.
206	Potato Manure,	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
211	Vegetable Bone Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
215	Special Potato Manure,	Pacific Guano Company, Boston, Mass.,	Newburyport.
226	Cumberland Superphosphate,	Cumberland Bone Phosphate Company, Portland, Me.,	Lawrence.
229	Alkaline Bone Phosphate,	E. Frank Coe, New York, N. Y.,	Framingham.
238	Blood, Bone and Meat,	Williams & Clark Fertilizer Company, Boston, Mass.,	Dalton.

258	Grass and Grain Fertilizer,	Great Eastern Fertilizer Company, Rutland, Vt.,	Westfield.
263	Fish and Potash,	Leander Wilcox, Mystic, Conn.,	Amherst.
	Bones.		
1	Pure Bone Meal,	Thomas Stetson, Randolph, Mass.,	Amherst.
78	Ground Bone,	John L. Bonzey, Auburn, Mass.,	Auburn.
83	Fresh Ground Bone,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
100	Pure Bone Meal,	Thomas Hersom & Co., New Bedford, Mass.,	New Bedford.
121	Pure Bone Meal,	Thomas Stetson, Randolph, Mass.,	Boston.
124	Fine-ground Bone,	Bradley Fertilizer Company, Boston, Mass ,	Boston.
131	Fine-ground Bone,	Hargraves Manufacturing Company, Fall River, Mass.,	Fall River.
189	Pure Bone Meal,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
233	Pure Ground Bone,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Haverhill.
239	Ground Bone,	John L. Bonzey, Auburn, Mass.,	Amherst.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
140	Cleveland Superphosphate,	14.13	3.46	2.05—2.95	4.61	4.75	2.10	11.46	11—14	9.36	9—11	2.06	2—3
151	Dry Ground Fish,	9.69	8.01	7.41—9.06	.87	4.24	1.59	6.70	7—9	5.11	-	-	-
155, 174	Ammoniated Bone Superphosphate,	9.67	2.50	2.47—3.30	6.38	6.40	1.26	14.04	-	12.78	9—11	2.93	2—3
160	Ammoniated Bone Superphosphate,	10.21	3.40	2.90—3.70	7.50	2.68	.73	10.91	11—14	10.18	10—12	1.82	1—2
165	Fine-ground Bone and Potash, "Circle Brand,"	11.15	2.26	1.85—2.68	1.56	7.06	3.10	11.72	8—12	8.62	-	2.42	2—3
171	Special Potato Manure,	13.01	3.79	3.70—4.50	6.40	2.30	.46	9.16	9—11	8.70	8—9	5.67	5.40—6.40
178	High-grade Tobacco Manure,	6.26	6.04	5.77—6.59	.61	3.18	1.28	5.07	4—5	3.79	-	12.75	10.81—12.43*
181	Potato Phosphate,	17.92	2.78	2.47—3.30	4.25	2.50	1.28	8.03	7—11	6.75	6—9	4.60	5—6*
186	Complete Tobacco Manure,	7.59	4.88	4.53—5.36	4.09	.21	.87	5.17	-	4.30	3—5	10.65	10—12
198, 226	Cumberland Superphosphate,	14.35	2.28	2.06—2.88	5.76	2.88	2.68	11.32	10—12	8.64	8—10	2.40	2—3*
206	Potato Manure,	10.48	2.44	2.47—3.30	3.48	3.33	2.15	8.96	7—11	6.81	6—9	4.79	5—6*
211	Vegetable Bone Superphosphate,	13.55	5.06	5—6	5.12	1.07	.82	7.01	7—9	6.19	6—7	6.34	6—8*

215	Special Potato Manure,	12.12	2.80	2.47—3.30	2.61	3.33	1.94	7.88	7—10	5.94	5—7	5.52		5—6*	
229	Alkaline Bone Phosphate,	9.70	1.50	1—1.5	6.40	1.37	3.74	11.51	10—14	7.77	9—12	2.69		1.62—2.16*	
238	Blood, Bone and Meat,	7.13	8.31	-	.46	7.42	2.87	10.75	-	7.88	-	-		-	
258	Grass and Grain Fertilizer,	14.94	2.46	2.88—3.71	6.29	1.74	1.18	9.21	9—15	8.03	8—12	3.49		2—4	
263	Fish and Potash,	14.37	3.48	3.25—4.25	2.66	3.94	.72	7.32	6—7	6.60	5—6	5.23		4—5	
												MECHANICAL ANALYSIS.			
	Bones.											Fine.	Med. Fine.	Med.	Coarse Med.
1, 121	Pure Bone Meal,	8.70	3.96	3—4	.38	9.48	12.02	23.88	20—26	9.86	-	14.95	25.30	35.96	23.79
78, 239	Ground Bone,	8.43	3.87	3.87	.30	16.74	3.68	20.72	20.72	17.04	-	42.30	37.60	15.00	5.10
83	Fresh Ground Bone,	8.94	2.88	2.47—3.30	.31	17.45	3.48	21.24	18—22	17.76	5—7	21.20	38.10	40.70	-
100	Pure Bone Meal,	4.95	1.88	2	.12	25.08	5.12	30.32	29.21	25.20	-	74.83	15.49	6.68	3.00
124	Fine-ground Bone,	7.10	3.60	2.5—3.25	.05	17.81	1.33	19.19	21—23	17.86	-	51.50	30.80	17.70	-
131	Fine-ground Bone,	7.71	3.48	2.5—2.8	.41	21.34	1.33	23.08	25—27	21.75	-	29.20	22.20	17.40	31.20
189	Pure Bone Meal,	4.62	2.65	2.47—4.12	.31	12.34	6.01	18.66	20—25	12.65	-	54.80	33.80	11.40	-
233	Pure Ground Bone,	7.67	4.80	2.88—3.71	-	14.34	8.44	22.78	24—26	14.34	-	17.64	25.90	25.12	31.34

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
2	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
10	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
39	Market Garden Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Springfield.
51	Odorless Phosphate,	Allison, Stroup & Co., Boston, Mass.,	Amherst.
84	Complete Top-dressing Manure,	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
86	Fish and Potash, "D Brand,"	Bowker Fertilizer Company, Boston, Mass.,	Springfield.
87	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Monson.
96	Strawberry Manure,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
102	Bristol Fish and Potash,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
103	Potato Manure,	M. E. Wheeler & Co., Rutland, Vt.,	Bridgewater.
109	Farm and Garden Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Dighton.
112	Standard Fertilizer,	Read Fertilizer Company, Syracuse, N. Y.,	West Bridgewater.
115	Potato and Root Fertilizer,	Wm. J. Brightman & Co., Tiverton, R. I.,	West Bridgewater.
116	High-grade Farmers' Friend,	Read Fertilizer Company, Syracuse, N. Y.,	West Bridgewater.
117	Lawn and Garden Dressing,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
119	Sheep Fertilizer,	John J. Peters, Long Island City, N. Y.,	Boston.
123	Wood Ashes,	Allison, Stroup & Co., Boston, Mass.,	Boston.

129	A A Ammoniated Superphosphate,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
133	Fish and Potash, "D Brand,"	Daniel T. Church & Co., Providence, R. I.,	Dighton.
137	Meat and Bone,	Thomas Hersom & Co , New Bedford, Mass.,	New Bedford.
138	Potato and Root Fertilizer,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
139	Potato Phosphate,	Cleveland Dryer Company, Boston, Mass.,	South Framingham.
142	Bay State Bone Superphosphate,	H. F. Tucker, Boston, Mass.,	Taunton.
143	Plymouth Rock Brand,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
147	Ammoniated Dissolved Bone,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
148	Grass and Grain Fertilizer,	E. Frank Coe, New York, N. Y.,	Williamstown.
156	Dry Fish Guano,	Bradley Fertilizer Company, Boston, Mass.,	Northampton.
158	Potato Manure,	E. Frank Coe, New York, N. Y.,	Lee.
167	Special Favorite,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.
250	Potato Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
2, 250	Potato Special,	12.01	1.54	2.47—3.30	6.45	2.20	1.94	10.59	12—13	8.65	10—11	6.12	5—6
10, 103	Potato Manure,	12.80	2.12	2.06—2.88	5.07	3.27	1.38	9.72	9—15	8.34	8—12	6.46	3.75—4.50
39	Market-garden Manure,	11.46	3.78	3.30—4.12	3.74	5.83	1.02	10.59	9—13	9.57	8—11	7.02	7—8
51	Odorless Phosphate,	.39	-	-	-	-	-	20.84	18	-	-	-	-
64	Complete Top-dressing Manure,	6.40	5.04	5—6	2.05	5.01	2.92	9.98	6—7	7.06	4—6	7.19	6—7
86	Fish and Potash, "D Brand,"	6.95	3.14	2.14—3.14	2.15	3.88	5.48	11.51	8—10	6.03	-	4.09	2—3
87, 167	Special Favorite,	6.57	1.50	1.24—2.06	5.88	6.25	2.97	15.10	11—14	12.13	10—12	1.63	1.5—2.5*
96	Strawberry Manure,	12.25	2.77	2.88	2.89	4.13	1.30	8.32	6	7.02	-	9.04	8
102	Bristol Fish and Potash,	15.72	2.04	1.6—2.5	2.58	5.31	3.79	11.68	8—10	7.89	5—8	1.94	2—3
109	Farm and Garden Phosphate,	11.98	2.14	1.5—2.5	2.61	5.59	2.70	10.90	10—14	8.20	8—11	2.13	2—3
112	Standard Fertilizer,	14.12	1.17	.8	6.09	2.25	.72	9.06	9—12	8.34	8	4.36	4—6

115, 138	Potato and Root Fertilizer,	10.71	3.72	3.73—4.52	4.30	4.68	1.82	10.80	9—12	8.98	8—11	5.83	6—7
116	High-grade Farmers' Friend,	11.20	3.34	3.30—4.12	4.61	1.54	1.07	7.22	6	6.15	5—6	10.86	10—11
117	Lawn and Garden Dressing,	7.22	3.30	4.12—4.94	1.82	4.27	1.59	7.68	-	6.09	5—6	5.54	5—6
119	Sheep Fertilizer,	13.44	2.14	1.65	-	-	-	1.59	1.20	-	-	1.64	1.70
123	Wood Ashes,	19.62	-	-	-	-	-	1.74	1.36—1.83	-	-	4.70	5.84—6.80
129	A A Ammoniated Superphosphate,	12.77	3.15	2.47—3.30	5.25	5.22	2.02	12.49	-	10.47	10—12	2.32	2—3
133	Fish and Potash, "D Brand,"	19.94	2.53	2.07—2.90	3.63	3.43	.92	7.98	7.50—10.50	7.06	6—8	2.48	2—3
137	Meat and Bone,	5.73	5.53	4.24	.72	10.36	7.96	19.04	19—25	11.08	-	-	-
139	Potato Phosphate,	13.83	1.96	2.05—2.85	3.17	6.48	1.61	11.26	10—13	9.65	8—10	3.56	3—4*
142	Bay State Bone Superphosphate,	11.85	2.02	2	6.04	2.98	2.70	11.72	11—15	9.02	9—12	2.08	1.85
143	Plymouth Rock Brand,	12.55	3.29	3.30—4.12	4.50	5.91	1.74	12.15	9—13	10.41	8—11	4.59	4—4.5
147	Ammoniated Dissolved Bone,	13.01	1.66	1.65—2.47	4.91	4.92	1.48	11.31	10—13	9.83	9—11	2.18	2—3
148	Grass and Grain Fertilizer,	12.12	1.30	.80—1.65	4.61	7.50	.84	13.05	10—13	12.11	9—11	1.66	1.35—1.90
156	Dry Fish Guano,	12.13	8.50	7.41—9.06	.87	4.30	.77	5.94	7—9	5.17	-	-	-
158	Potato Manure,	14.39	2.24	2—2.50	6.47	2.13	3.07	11.67	10—14	8.60	8—11	5.72	6—7

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
168	Potato and Root Crop Manure,	Prentiss, Brooks & Co., Holyoke, Mass.,	Westfield.
169	Excelsior Tobacco Grower,	E. Frank Coe, New York, N. Y.,	Westfield.
173	Fish and Potash, "Plain Brand,"	Quinnipiac Fertilizer Company, Boston, Mass.,	Westfield.
175	Ground Bone and Potash,	E. Frank Coe, New York, N. Y.,	Lee.
177	Dry Ground Fish,	Bowker Fertilizer Company, Boston, Mass.,	Northampton.
184	Potato, Onion and Tobacco Grower,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
185	Fish and Potash, "Americus Brand,"	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield..
194	West Andover Market Bone Phosphate,	James E. McGovern, West Andover, Mass.,	Lawrence.
195	Tobacco and Sulphur,	F. C. Sturtevant, Hartford, Conn.,	Fitchburg.
205	King Philip Guano,	Clark Cove Fertilizer Company, Boston, Mass.,	Lawrence.
218	Tankage and Bone,	Lowe Brothers & Co., Fitchburg, Mass.,	Fitchburg.
222	Royal Bone Phosphate,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
228	Eclipse Phosphate,	Bradley Fertilizer Company, Boston, Mass.,	Newburyport.
230	Lawrence Fertilizer,	A. Lee & Co., Lawrence, Mass.,	Lawrence.
234	Potato and Tobacco Fertilizer,	Clark Cove Fertilizer Company, Boston, Mass.,	Lawrence.
235	Soluble Pacific Guano,	Pacific Guano Company, Boston, Mass.,	Newburyport.
237	West Andover Market Bone Phosphate,	James E. McGovern, Lawrence, Mass.,	Amherst.

241	Potato, Onion and Tobacco Fertilizer,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
246	Potato and Tobacco Manure,	Standard Fertilizer Company, Boston, Mass.,	Ludlow.
247	Pride of the Valley,	Kirley Fertilizer Company, South Hadley Falls, Mass.,	South Hadley Falls.
267	Oats, Buckwheat and Seeding-down,	Great Eastern Fertilizer Company, Rutland, Vt.,	Orange.
270	Havana Tobacco Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Hatfield.
272	Fish and Potash,	Pacific Guano Company, Boston, Mass.,	Belchertown.
274	Pride of the Valley,	Kirley Fertilizer Company, South Hadley Falls, Mass.,	Amherst.
	Bones.		
33	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Worcester.
34	Pure Fine-ground Bone,	J. G. Jefferds, Worcester, Mass.,	Worcester.
125	Pure Ground Bone,	C. A. Bartlett, Worcester, Mass.,	Boston.
196	Pure Fine-ground Bone,	J. G Jefferds, Worcester, Mass.,	Hudson.
199	Bone Meal,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
221	Ground Bone,	James E. McGovern, West Andover, Mass.,	Lawrence.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
168	Potash and Root Crop Manure,	7.88	4.35	4.12—4.94	5.07	3.38	1.43	9.88	7—9	8.45	5—6	7.45	7—9*
169	Excelsior Tobacco Grower,	9.35	4.10	3—4	6.70	2.18	3.07	11.95	8—11	8.88	8—11	5.64	5—6*
173	Fish and Potash, "Plain Brand,"	17.83	2.50	2.06—2.88	3.89	1.44	.61	5.94	6—9	5.33	4—6	4.04	4—6
175	Ground Bone and Potash,	4.23	1.27	-	.33	9.99	4.82	14.14	-	10.32	-	12.48	-
177	Dry Ground Fish,	13.92	7.70	8—10	1.36	3.22	2.56	7.14	7—8	4.58	-	-	-
184	Potato, Onion and Tobacco Grower,	9.62	3.62	3.71—4.12	2.71	6.19	1.28	10.18	8—11	8.90	7—9	7.44	7—9
185	Fish and Potash, "Americus Brand,"	16.68	2.35	2.06—2.88	4.09	2.82	1.07	7.98	6—9	6.91	4—6	2.48	4—6
194 237	West Andover Market Bone Phosphate,	12.58	1.56	2—3	4.02	9.62	.36	14.02	13—15	13.64	-	1.96	3—4
195	Tobacco and Sulphur,	13.08	2.20	1.96	-	-	-	.87	.75	-	-	7.67	7.66
205	King Philip Guano,	16.67	1.16	.91—1.65	5.94	3.53	.92	10.39	9—12	9.47	8—10	2.21	2—3
218	Tankage and Bone,	4.26	2.84	-	-	-	-	21.38	-	-	-	-	-
222	Royal Bone Phosphate,	17.38	1.45	1—1.64	3.89	6.09	1.15	11.13	8—12	9.98	7—10	2.66	2—3
228	Eclipse Phosphate,	13.93	1.20	1—2	4.71	4.50	2.30	11.51	10—14	9.21	8—11	1.82	1.5—2.5

230	Lawrence Fertilizer,	13.54	1.62	2.06–2.88	2.81	6.24	2.23	11.28	10–12	9.05	-	2.10	2–3
234	Potato and Tobacco Fertilizer,	11.60	1.92	2.06–2.80	2.56	6.90	1.54	11.00	9–14	9.46	8–11	2.94	3–4*
235	Soluble Pacific Guano,	13.06	2.06	2.25–3.00	6.88	2.70	.82	10.44	10.50–16	9.58	8.50–11	2.23	2–3.50
241	Potato, Onion and Tobacco Fertilizer,	14.42	3.39	3.25–4.25	4.76	3.66	1.07	9.49	8–9	8.42	6–8	6.17	6–7
246	Potato and Tobacco Manure,	12.51	2.94	2.06–2.88	4.20	5.21	2.00	11.41	9–13	9.41	8–11	3.08	3–4*
247, 274	Pride of the Valley,	13.81	1.54	2.06–2.88	.82	6.34	.49	7.65	7–9	7.16	-	3.16	2.70–3.78*
267	Oats, Buckwheat and Seeding-down,	13.79	1.14	.82–1.65	.77	7.39	.90	9.06	9–15	8.16	8–12	5.04	4–6
270	Havana Tobacco Fertilizer,	10.15	6.38	5.77–6.59	1.38	1.59	.97	3.94	6–9	2.97	5–7	10.88	10–12
272	Fish and Potash,	18.67	3.48	2.06–2.88	3.04	2.82	.69	6.55	6–10	5.86	4–7	3.77	4–6

Bones.

												Mechanical Analysis.			
												Fine.	Med. Fine.	Med.	Coarse Med.
33, 125	Pure Ground Bone,	4.12	2.85	2–3	.49	18.88	7.80	27.17	27–29	19.37	-	57.08	28.60	13.77	.54
34, 196	Pure Fine-ground Bone,	3.04	1.36	2.47–4.12	-	25.84	3.17	29.01	25–30	25.84	-	75.06	22.94	2.00	-
199	Bone Meal,	6.25	3.80	2–3	.03	16.29	7.60	23.92	25–28	16.32	-	38.35	29.25	21.92	10.48
221	Ground Bone,	8.87	1.80	-	.03	16.61	2.94	19.58	-	16.64	-	51.88	18.94	12.80	16.38

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
4	Tobacco Special,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
5	Four Fold,	Walker, Stratman & Co., Pittsburg, Pa.,	Amherst.
11	Grass and Oats Fertilizer,	M. E. Wheeler & Co., Rutland, Vt.,	Amherst.
16	Pulverized Bone and Meat,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
26	Animal Fertilizer,	J. G. Jefferds, Worcester, Mass.,	Worcester.
64	Dry Ground Fish Guano,	National Fertilizer Company, Bridgeport, Conn.,	Hadley.
88	Vegetator,	Davidge Fertilizer Company, New York, N. Y.,	Monson.
91	Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Amherst.
101	Harvest Home Phosphate,	H. J. Baker & Bro., New York, N. Y.,	Fall River.
126	Strawberry Fertilizer,	Ames Fertilizer Company, Peabody, Mass.,	Dighton.
130	Nitrogenous Superphosphate,	John C. Dow & Co., Boston, Mass.,	Dighton.
132	Manhaden Fish Guano,	W. J. Brightman & Co., Tiverton, R. I.,	Dighton.
134	Potato Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Dighton.
135	Economical Manure,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Dighton.
136	Church's B Special Fertilizer,	Daniel T. Church & Co., Providence, R. I.,	Dighton.
154	Sheep Fertilizer,	Wm. Elliott & Sons, New York, N. Y.,	Pittsfield.
162	Wheat and Corn Fertilizer,	Davidge Fertilizer Company, New York, N. Y.,	Westfield.

163	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	North Adams.
183	Ammoniated Wheat and Corn Phosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Greenfield.
188	Sure Crop Phosphate,	Bowker Fertilizer Company, Boston, Mass.,	Shelburne Falls.
192	Grass Manure,	Williams & Clark Fertilizer Company, Boston, Mass.,	Greenfield.
193	Grass Fertilizer,	Quinnipiac Fertilizer Company, Boston, Mass.,	Williamstown.
200	Superphosphate,	William Lavery, Amesbury, Mass.,	Amesbury.
203	Gold Brand Excelsior Guano,	E. Frank Coe, New York, N. Y.,	Framingham.
204	Potato Fertilizer,	Cumberland Bone Phosphate Company, Boston, Mass.,	Hudson.
209	Great Planet "A,"	Clark Cove Fertilizer Company, Boston, Mass.,	Hudson.
219	Superphosphate,	William Lavery, Amesbury, Mass.,	Amesbury.
227	Potato Fertilizer,	Cumberland Bone Phosphate Company, Boston, Mass.,	Lowell.
252	Four Fold,	Walker, Stratman & Co., Pittsburg, Pa.,	Leeds.
257	Great Planet "A,"	Clark Cove Fertilizer Company, Boston, Mass.,	Westfield.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
4	Tobacco Special,	8.79	2.37	2.47—3.30	6.75	3.23	.97	10.95	10—12	9.98	8—10	4.00	3.24—4.32*
5, 252	Four Fold,	9.95	1.80	1.65—2.47	5.99	3.68	1.64	11.31	10—11	9.67	8—9	1.66	2—3*
11	Grass and Oats Fertilizer,	15.42	–	–	6.26	3.18	.16	9.60	12—18	9.44	10—14	2.33	2—4*
16	Pulverized Bone and Meat,	6.17	5.60	4.94—5.77	.26	7.72	9.98	17.96	18—20	7.98	–	–	–
26	Animal Fertilizer,	10.51	2.50	2.47—3.30	4.76	6.21	6.35	17.32	16—18	10.97	11—13	2.58	2.5—3.5
64	Dry Ground Fish Guano,	9.64	7.41	–	.64	5.70	.72	7.06	–	6.34	–	–	–
88	Vegetator,	12.37	2.10	2.06—3.71	9.22	1.86	1.28	12.36	–	11.08	5—7	1.92	3—5
91, 130	Nitrogenous Superphosphate,	16.10	2.10	2.06—2.88	2.97	7.63	1.94	12.54	8—10	10.60	–	4.37	1.89—2.53
101	Harvest Home Phosphate,	12.21	1.46	1.03—1.65	1.64	7.63	1.07	10.34	–	9.27	8—10	3.36	2—2.5
126	Strawberry Fertilizer,	13.00	2.70	2.47—3.30	4.73	3.97	3.15	11.85	10—12	8.70	9—11	6.42	6—7
132	Manhaden Fish Guano,	9.81	8.20	8.24—9.89	1.05	3.54	2.46	7.05	6.87—9.16	4.59	–	–	–
134	Potato Manure,	6.23	3.80	3.71—4.12	2.12	3.74	2.38	8.24	8—10	5.86	8	8.36	6—8*

135	Economical Manure,	11.42	2.78	2.47—3.30	4.25	3.93	.31	8.49	8—10	8.18	6—8	9.86	8—10
136	Church's B Special Fertilizer,	11.48	3.40	3.73—4.52	1.84	6.30	2.71	10.85	9—13	8.14	8—11	6.16	6—7
154	Sheep Fertilizer,	9.40	1.91	-	-	-	-	2.18	-	-	-	3.02	-
162	Wheat and Corn Fertilizer,	11.52	1.01	.82—1.65	10.50	2.34	1.66	14.50	8—12	12.84	7—9	1.24	1—2
163 183	Ammoniated Wheat and Corn Phosphate,	12.64	2.26	2—3	6.70	3.54	1.79	12.03	-	10.24	10—13	1.35	1.60—2.70
188	Sure Crop Phosphate,	11.75	.90	.75—1.50	4.35	4.96	3.28	12.59	-	9.31	8—10	1.17	1—2
192	Grass Manure,	11.23	3.44	3.91—4.74	2.25	3.43	1.07	6.75	6—8	5.68	5—7	2.39	2—3
193	Grass Fertilizer,	10.36	3.10	3.91—4.74	2.48	4.12	1.18	7.78	6—8	6.60	5—7	2.33	2—3
200 219	Superphosphate,	16.10	1.75	1.97	1.07	6.70	.72	8.49	-	7.77	10.17	1.28	2.36
203	Gold Brand Excelsior Guano,	7.70	2.60	2.5—3	6.70	2.41	1.94	11.05	9—13	9.11	8—11	6.25	6—8
204 227	Potato Fertilizer,	15.52	1.91	2.06—2.88	6.04	3.25	1.30	10.59	11—13	9.29	9—11	3.40	3—4
209 257	Great Planet "A,"	10.44	3.16	3.30—4.12	2.56	7.06	2.35	11.97	9—13.50	9.62	8—11.50	7.21	7—8

* Sulphate of potash, the source of potash.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Compound Fertilizers.		
210	New Rival Ammoniated Superphosphate,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Newburyport.
213	New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Lowell.
217	Lawn Fertilizer,	Crocker Fertilizer and Chemical Company, Buffalo, N. Y.,	Fitchburg.
223	New Method Fertilizer,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
236	Prolific Crop Producer,	Williams & Clark Fertilizer Company, Boston, Mass.,	Lowell.
248	Standard Superphosphate,	Standard Fertilizer Company, Boston, Mass.,	Ludlow.
251	Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	East Longmeadow.
253	Ammoniated Bone Superphosphate,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
259	Bay State G G,	Clark Cove Fertilizer Company, Boston, Mass.,	East Longmeadow.
260	Corn Manure,	H. J. Baker & Bro., New York, N. Y.,	Northampton.
262	Dry Ground Fish Guano,	Leander Wilcox, Mystic, Conn.,	Amherst.
264	Connecticut Wrapper Fertilizer,	Cleveland Linseed Oil Company, Cleveland, Ohio,	Amherst.
265	Coarse Linseed Meal,	Cleveland Linseed Oil Company, Cleveland, Ohio,	South Deerfield.
268	Onion Manure,	Quinnipiac Fertilizer Company, Boston, Mass.,	Hatfield.
269	Corn and Grain Phosphate,	Cleveland Dryer Company, Boston, Mass.,	Monson.
271	Lawn and Garden Fertilizer,	L. B. Darling Fertilizer Company, Pawtucket, R. I.,	Worcester.
273	High-grade General Fertilizer,	Pacific Guano Company, Boston, Mass.,	Belchertown.

	Chemicals.		
24	Nitrate of Soda,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
25	Nitrate of Soda,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
50	Sulphate of Potash and Magnesia,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
59	Sulphate of Potash and Magnesia,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
	Bones.		
207	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amherst.
231	Pure Ground Bone,	Wm. Lavery, Amesbury, Mass.,	Amesbury.
240	Ground Bone,	Bryant & Brett, New Bedford, Mass.,	Amherst.
256	Ground Bone,	H. J. Baker & Bro., New York, N. Y.,	East Longmeadow.

4. Analyses of Licensed Fertilizers, etc. — *Continued.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen in One Hundred Pounds.		Phosphoric Acid in One Hundred Pounds.							Potassium Oxide in One Hundred Pounds.	
								Total.		Available.			
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
	Compound Fertilizers.												
210	New Rival Ammoniated Superphosphate,	11.25	1.26	1.20—2.00	5.01	3.69	1.79	10.49	11—14	8.70	10—12	2.32	1.60 3.00
213, 223	New Method Fertilizer,	12.83	1.33	.82—1.65	5.12	3.53	1.43	10.08	10—12	8.65	8—10	2.20	2.16—3.24
217	Lawn Fertilizer,	3.75	2.49	3.29—4.00	-	8.92	17.92	26.84	19—22	8.92	-	1.30	3.25—4.30
236	Prolific Crop Producer,	12.97	1.19	.82—1.65	4.86	3.70	2.18	10.74	7—11	8.56	6—9	2.17	1—2
248	Standard Superphosphate,	11.78	2.48	2.5—3.5	4.09	5.32	2.10	11.51	11—16	9.41	9—13	2.00	2—3
251, 260	Corn Manure,	7.54	4.19	4.12	2.92	4.04	1.74	8.70	-	6.96	6.25	7.50	7
253	Ammoniated Bone Superphosphate,	15.70	2.88	2.50—3.50	3.96	2.68	1.80	8.44	7—8	6.64	6—7	6.02	5—6
259	Bay State "G G,"	12.32	2.41	1.85—2.68	6.02	3.06	3.46	12.54	10—13	9.08	8.50—11	1.88	2—3
262	Dry Ground Fish Guano,	8.85	8.60	8—10	.52	4.40	2.82	7.74	6—8	4.92	4—6	-	-
264	Connecticut Wrapper Fertilizer,	5.90	4.16	4.5—5.25	.52	4.46	2.56	7.54	5.70—6.20	4.98	-	13.18	10—11
265	Coarse Linseed Meal,	9.27	6.54	5.90—6.00	-	-	-	2.10	2	-	-	1.71	1.40—1.50
268	Onion Manure,	10.12	3.38	3.30—4.12	2.44	4.98	3.58	11.00	9—13	7.42	8—11	7.66	7—8*

269	Corn and Grain Phosphate,	15.88	1.97	2.02—2.88	5.17	4.60	.72	10.49	10.50—14.50	9.77	9.50—12.50	2.44	1.50—2.50		
271	Lawn and Garden Fertilizer,	10.27	3.58	4.94—6.59	4.78	2.20	3.38	10.36	10—12	6.98	-	5.77	5—6		
273	High-grade General Fertilizer,	11.18	3.64	2.68—3.50	3.33	4.04	2.30	9.67	9—13	7.37	8—11	6.36	7—8*		
	Chemicals.														
24	Nitrate of Soda,	.76	15.68	15.66—16.48	-	-	-	-	-	-	-	-	-		
25	Nitrate of Soda,	.97	16.04	15.66—16.48	-	-	-	-	-	-	-	-	-		
50	Sulphate of Potash and Magnesia,	2.01	-	-	-	-	-	-	-	-	-	25.08	25.94—28.10		
59	Sulphate of Potash and Magnesia,	4.31	-	-	-	-	-	-	-	-	-	28.63	25.94—28.10		
												Mechanical Analysis.			
	Bones.											Fine.	Med Fine.	Med.	Coarse Med.
207 231	Pure Ground Bone,	11.92	3.42	-	-	3.96	5.38	9.34	-	3.96	-	32.54	24.05	36.81	6.60
240	Ground Bone,	3.92	2.90	2.50	.38	7.45	18.54	26.37	25.56	7.83	-	26.53	26.80	31.77	14.90
256	Ground Bone	7.27	4.36	3.30—3.71	.67	8.64	11.64	20.95	22—25	9.31	-	38.58	44.28	17.14	-

* Sulphate of potash, the source of potash.

4. ANALYSES OF LICENSED FERTILIZERS, ETC. — *Continued.*

Laboratory Number.	Name of Brand.	Name of Manufacturer.	Sampled at —
	Chemicals.		
13	Muriate of Potash,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
23	Muriate of Potash,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
44	Dried Blood,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
48	Muriate of Potash,	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
49	Sulphate of Potash, "High Grade,"	Bowker Fertilizer Company, Boston, Mass.,	Amherst.
52	Sulphate of Ammonia,	Quinnipiac Fertilizer Company, Boston, Mass.,	Sunderland.
54	Sulphate of Ammonia,	Lucien Sanderson, New Haven, Conn.,	Sunderland.
57	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Sunderland.
72	Sulphate of Potash, "High Grade,"	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
75	Muriate of Potash,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
118	Muriate of Potash,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
128	Nitrate of Soda,	Bradley Fertilizer Company, Boston, Mass.,	Boston.
153	Muriate of Potash,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
191	Nitrate of Soda,	H. J. Baker & Bro., New York, N. Y.,	South Deerfield.
216	Sulphate of Ammonia,	Bradley Fertilizer Company, Boston, Mass.,	Amesbury.
224	Nitrate of Soda,	Williams & Clark Fertilizer Company, Boston, Mass.,	Hadley.
225	Nitrate of Soda,	Prentiss, Brooks & Co., Holyoke, Mass.,	Holyoke.
232	Nitrate of Soda,	Mapes Formula and Peruvian Guano Company, New York, N. Y.,	Haverhill.
249	Muriate of Potash,	Leander Wilcox, Mystic, Conn.,	South Hadley Falls.
254	Nitrate of Soda,	Clark Cove Fertilizer Company, Boston, Mass.,	East Longmeadow.

4. Analyses of Licensed Fertilizers, etc. — *Concluded.*

Laboratory Number.	Name of Brand.	Moisture.	Nitrogen.		Potassium Oxide.	
			Found.	Guaranteed.	Found.	Guaranteed.
	Chemicals.					
13	Muriate of Potash,	1.03	-	-	51.08	50.54—53.70
23	Muriate of Potash,	1.37	-	-	50.52	50.54—53.70
44	Dried Blood,	5.56	9.70	9.89—11.53	-	-
48	Muriate of Potash,	.75	-	-	52.20	50.54—53.70
49	Sulphate of Potash, "High Grade,"	.33	-	-	50.80	48.64—51.34
52	Sulphate of Ammonia,	.33	20.81	20.60—21.42	-	-
54	Sulphate of Ammonia,	2.20	19.79	19.78—20.60	-	-
57 224	Nitrate of Soda,	1.27	15.87	15.48—15.81	-	-
72	Sulphate of Potash, "High Grade,"	.47	-	-	49.56	48.63—51.33
75	Muriate of Potash,	.14	-	-	52.36	50.54—53.70
118	Muriate of Potash,	.96	-	-	51.48	50.54—53-70
128	Nitrate of Soda,	1.58	16.22	14.83—16.48	-	-
153	Muriate of Potash,	.53	-	-	48.24	50.54—53.70
191	Nitrate of Soda,	1.26	15.32	14.82—15.64	-	-
216	Sulphate of Ammonia,	.25	20.84	20.60—21.42	-	-
225	Nitrate of Soda,	2.35	15.48	15.48—15.81	-	-
232	Nitrate of Soda,	1.27	16.02	-	-	-
249	Muriate of Potash,	2.65	-	-	51.72	50.54—53.70
254	Nitrate of Soda,	1.35	15.45	15.66	-	-

5. Analyses of Commercial Fertilizers and Manurial Substances sent on for Examination.

Wood Ashes.

[I., II. and III., sent on from Concord, Mass.; IV. and V., sent on from Lowell, Mass.; VI., sent on from Amherst, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI
Moisture at 100° C.,	6.75	15.38	6.05	23.00	19.10	7.97
Calcium oxide,	42.72	43.00	–	33.88	30.32	18.70
Phosphoric acid,	1.66	1.10	1.43	1.02	1.02	2.04
Potassium oxide,	6.02	5.23	6.54	3.01	5.18	7.48
Insoluble matter,	7.71	8.84	9.74	10.88	13.38	22.03

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Concord Junction, Mass.; IV., sent on from Amherst, Mass.; V., sent on from Rock Bottom, Mass.; VI., sent on from Walpole, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	14.96	9.86	5.93	1.29	14.69	16.06
Calcium oxide,	29.52	32.74	40.48	32.26	–	–
Phosphoric acid,	1.79	1.48	1.77	4.04	1.28	1.33
Potassium oxide,	5.25	6.17	7.84	9.20	5.04	5.20
Insoluble matter,	13.18	18.96	7.21	11.22	12.29	14.31

Wood Ashes.

[I., sent on from North Andover, Mass.; II., sent on from Hudson, Mass.; III., sent on from Westborough, Mass.; IV., V. and VI., sent on from Concord, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	19.11	.19	22.26	7.80	14.52	16.08
Calcium oxide,	38.20	36.70	30.24	33.00	36.50	32.61
Potassium oxide,	5.98	3.96	5.04	4.47	5.13	4.50
Phosphoric acid,	1.28	.90	1.15	1.13	1.68	1.22
Insoluble matter,	13.12	14.61	–*	10.28	11.03	13.70

* Not determined.

5. ANALYSES, ETC. — *Continued.*

Wood Ashes.

[I., sent on from Beverly, Mass.; II., sent on from Boston, Mass.; III. and IV., sent on from Concord, Mass.; V. and VI., sent on from Waltham, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	6.44	2.52	11.61	4.88	.57	10.92
Calcium oxide,	–*	34.46	35.05	30.20	28.17	33.13
Potassium oxide,	5.28	4.31	4.59	4.80	6.02	4.46
Phosphoric acid,	1.28	.67	.87	1.41	1.65	1.42
Insoluble matter,	15.40	12.63	15.97	15.61	16.87	23.65

Wood Ashes.

[I. and II., sent on from Concord, Mass.; III., sent on from Granby, Mass.; IV., sent on from Lakeville, Mass.; V., sent on from Sunderland, Mass.; VI., sent on from Leverett, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	9.67	11.13	20.51	6.45	12.59	16.69
Phosphoric acid,	1.43	1.43	1.36	.51	.82	1.59
Potassium oxide,	7.32	5.22	5.62	5.96	7.54	5.98
Insoluble matter,	8.94	23.13	17.08	–*	–*	–*

Wood Ashes.

[I., sent on from Concord, Mass.; II. and III., sent on from Beverly, Mass.; IV. and V., sent on from South Deerfield, Mass.; VI., sent on from South Sudbury, Mass.]

	PER CENT.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	12.32	10.17	2.05	2.33	13.65	33.23
Phosphoric acid,	1.42	1.61	1.79	1.54	1.46	.90
Potassium oxide,	6.40	5.21	4.64	6.09	4.68	4.09
Insoluble matter,	10.27	–*	–*	–*	–*	9.79

* Not determined.

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I. and II., sent on from Waltham, Mass.; III. and IV., sent on from Northfield, Mass.; V., sent on from Sunderland, Mass.; VI., sent on from South Hadley, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	11.75	9.25	12.20	6.25	20.60	2.35
Phosphoric acid,	1.71	1.38	1.33	1.33	1.56	1.71
Potassium oxide,	5.10	4.32	5.18	4.65	4.78	3.46
Insoluble matter,	–*	23.78	17.16	24.44	–*	–*

Wood Ashes.

[I., sent on from South Sudbury, Mass.; II., sent on from South Framingham, Mass.; III., sent on from South Amherst, Mass.; IV., sent on from Concord, Mass.; V., sent on from North Hadley, Mass.; VI., sent on from West Northfield, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	11.77	3.23	17.20	10.38	11.41	18.30
Phosphoric acid,	1.44	1.26	1.66	1.28	1.62	1.40
Potassium oxide,	5.20	4.12	4.24	5.76	6.12	5.20
Insoluble matter,	19.40	–*	13.05	–*	9.34	8.87

Wood Ashes.

[I. and II., sent on from Beverly, Mass.; III., sent on from Lawrence, Mass.; IV., sent on from Danvers, Mass.; V., sent on from Lunenburg, Mass.; VI., sent on from Arlington, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	2.62	6.10	19.52	10.87	18.73	7.05
Phosphoric acid,	1.28	1.54	1.50	.56	1.02	1.36
Potassium oxide,	4.73	5.84	6.04	6.32	8.71	5.81
Insoluble matter,	–*	8.85	12.48	20.22	10.94	23.82

* Not determined.

5. Analyses, etc. — *Continued.*

Wood Ashes.

[I., sent on from Bernardston, Mass.; II., sent on from Concord, Mass.; III., sent on from Amherst, Mass.; IV., sent on from Methuen, Mass.; V. and VI., sent on from Concord, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	20.58	12.32	7.57	15.39	13.60	17.80
Phosphoric acid,	1.36	1.42	1.60	1.80	1.18	1.36
Potassium oxide,	3.68	6.40	8.50	4.60	5.39	5.75
Insoluble matter,	9.80	10.27	8.48	–*	17.48	10.36

Wood Ashes.

[All sent on from Concord, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	15.22	21.36	19.48
Phosphoric acid,	1.07	–	.98
Potassium oxide,	5.07	1.20	6.08
Insoluble matter,	12.46	3.66	9.90

Cotton-hull Ashes.

[I., sent on from North Hadley, Mass.; II. and III., sent on from Hatfield, Mass.; IV., sent on from Sunderland, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.72	9.45	11.00	7.89
Phosphoric acid,	9.40	9.96	6.84	5.46
Potassium oxide,	25.50	25.48	15.40	26.36
Insoluble matter,	6.08	–*	–*	–*

* Not determined.

5. Analyses, etc. — *Continued.*

Lime-kiln Ashes.

[I., sent on from Sunderland, Mass.; II. and III., sent on from Amherst, Mass]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	.68	24.09	15.01
Phosphoric acid,	1.48	1.57	.77
Potassium oxide,	5.20	1.57	.77
Calcium oxide,	–*	36.69	45.28
Insoluble matter,	–*	11.76	3.31

* Not determined.

Swill Ashes (from Cremation Furnace).

[Sent on from Amherst, Mass.]

	Per Cent.						
	I.	II.	III.	IV.	V.	VI.	VII.
Moisture at 100° C.,	2.43	19.46	12.48	.37	7.57	14.24	8.05
Potassium oxide,	1.59	1.78	3.35	4.27	3.96	5.09	4.92
Phosphoric acid,	25.89	5.22	6.50	12.97	13.92	6.86	13.22
Insoluble matter,	17.93	30.81	31.54	34.91	19.96	37.76	24.52

Lime and Ashes.

[Sent on from Boston, Mass.]

	Per Cent.
Moisture at 100° C.,	.65
Calcium oxide,	57.17
Potassium oxide,	.77
Phosphoric acid,	1.02
Insoluble matter,	13.86

Coal Ashes.

[Sent on from Framingham.]

	Per Cent.
Moisture at 100° C.,	32.37
Potassium oxide,	.42
Phosphoric acid,	.37
Nitrogen,	.33
Insoluble matter,	34.52

5. ANALYSES, ETC. — *Continued.*

Refuse Materials.

[I., refuse from calico works, sent on from Seekonk, Mass.; II., hair waste, sent on from Concord, Mass.; III. and IV., cotton waste, sent on from Concord, Mass.; V., wool waste, sent on from Lawrence, Mass.]

	Per Cent				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.07	72.81	10.01	10.93	2.23
Phosphoric acid,	11.95	.61	.31	1.80	.38
Potassium oxide,	–	.32	1.20	1.51	3.50
Nitrogen,	4.28	1.79	3.43	9.33	.96

Muck.

[Sent on from North Wilbraham, Mass.; I., light colored; II., dark colored.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	53.06	80.42
Calcium oxide,	.73	.22
Potassium oxide,	.05	.06
Phosphoric acid,	.04	.05
Nitrogen,	.52	.44
Insoluble matter,	38.35	6.06

Muck.

[I., sent on from South Amherst, Mass.; II., sent on from Plymouth, Mass.; III., sent on from Miller's Falls, Mass.]

	Per Cent.		
	I	II.	III.
Moisture at 100° C.,	70.02	61.53	76.75
Ash,	11.54	30.05	4.38
Nitrogen,	.69	.43	.40

Soot.

[Sent on from South Lancaster, Mass.]

	Per Cent.
Moisture at 100° C.,	5.39
Potassium oxide,	.52
Phosphoric acid,	.90

5. ANALYSES, ETC. — *Continued.*

Residue from Water Filter.

[Sent on from East Walpole, Mass.]

	Per Cent
Moisture at 100° C.,	94.22
Phosphoric acid,	.05
Nitrogen,	.12

Vegetable Mould.

[Sent on from Springfield, Mass.]

	Per Cent.
Moisture at 100° C.,	77.64
Nitrogen,	.30

Soot.

[Sent on from Lynn, Mass.; I., black; II., brown.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	2.09	.13
Phosphoric acid,	.74	2.10
Potassium oxide,	.46	.59
Nitrogen,	1.05	–

Barnyard Manure.

[Sent on from Hatfield, Mass.]

	Per Cent.
Moisture at 100° C.,	72.080
Phosphoric acid,	.304
Potassium oxide,	.641
Nitrogen,	.541
Insoluble matter,	2.730

Goose Manure.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	49.820
Phosphoric acid,	.957
Potassium oxide,	.810
Nitrogen,	.213

5. Analyses, etc. — *Continued.*

Hen House Refuse.

[Sent on from Fitchburg, Mass.]

	Per Cent.
Moisture at 100° C.,	3.43
Phosphoric acid,	1.28
Potassium oxide,	.60
Nitrogen,	.98

Waste Lime.

[Sent on from Amherst, Mass.]

	Per Cent.
Moisture at 100° C.,	.80
Calcium oxide,	74.12
Insoluble matter,	.38

Potash Magnesia Sulphate.

[Sent on from Hatfield, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	5.34	4.73	1.19
Potassium oxide,	26.80	26.32	27.28

Muriate of Potash.

[I. and II., sent on from Sunderland, Mass.; III., sent on from Leverett, Mass.; IV., sent on from Hudson, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	.91	.13	1.20	1.05
Potassium oxide,	52.50	49.00	52.60	51.16

5. ANALYSES, ETC. — *Continued.*

Florida Phosphate.

[I., soft variety, sent on from Boston, Mass.; II., sent on from Brookline, Mass.; III., sent on from South Hadley Falls, Mass.; IV., soft variety, sent on from South Chelmsford, Mass.]

	PER CENT.			
	I.	II.	III	IV.
Moisture at 100° C., ...	3.35	1.20	3.69	9.03
Calcium oxide, ...	30.22	32.80	–*	–*
Phosphoric acid, ...	19.94	24.49	20.79	18.54
Ferric and aluminic oxides, . . .	9.96	6.93	–*	–*
Potassium xide, ...	.29	–	–	–
Insoluble matter, ...	30.86	23.91	25.48	26.55

* Not determined.

Tankage.

[I., II., III, IV. and V., sent on from Boston, Mass.; VI., sent on from Concord, Mass.]

	PER CENT.					
	I.	II.	III	IV.	V.	VI.
Moisture at 100° C., .	9.24	9.23	14.95	9.01	6.27	10.33
Phosphoric acid, . .	10.84	12.28	10.23	12.60	11.25	4.03
Nitrogen, ...	6.94	8.27	8.72	8.26	7.51	9.16

Fish Waste.

[I, II. and III., sent on from Gloucester, Mass.; IV. and V., sent on from Boston, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C., ...	10.37	6.17	6.86	20.71	11.95
Phosphoric acid, ...	8.96	5.38	11.90	15.91	13.93
Nitrogen, ...	10.80	11.08	9.12	5.97	7.69

5. ANALYSES, ETC. — *Continued.*

Ground Bone.

[I., sent on from West Berlin, Mass.; II., III., IV. and V., sent on from Lincoln, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	4.97	3.76	4.31	4.04	3.64
Total phosphoric acid,	15.81	28.78	28.66	25.64	20.98
Available phosphoric acid,	15.71	–	–	–	–
Insoluble phosphoric acid,	.10	–	–	–	–
Nitrogen,	2.82	3.50	3.54	4.21	3.23

Ground Bone.

[I., sent on from Salisbury, Mass.; II., sent on from Townsend Harbor, Mass.; III., sent on from West Newbury, Mass.; IV., dissolved bone, sent on from Lancaster, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	34.55	5.84	3.95	8.79
Total phosphoric acid,	11.42	27.90	26.55	14.12
Available phosphoric acid,	–*	26.51	21.75	13.61
Insoluble phosphoric acid,	–*	1.39	4.80	.51
Nitrogen,	4.04	2.87	2.09	.59
Mechanical Analysis.				
Fine bone,	–*	39.27	58.35	–*
Fine medium bone,	–*	32.43	25.95	–*
Medium bone,	–*	25.00	15.70	–*
Coarse medium bone,	–*	3.30	–	–*
	–	100.00	100.00	–

* Not determined.

Cotton-seed Meal.

[I. and II., sent on from Hatfield, Mass.; III., sent on from Hadley, Mass. (damaged); IV., sent on from Amherst, Mass.]

	PER CENT.			
	I.	II.	III.	IV.
Moisture at 100° C.,	8.75	8.23	12.57	9.01
Total phosphoric acid,	2.12	3.08	2.48	2.11
Potassium oxide,	1.51	1.94	1.66	2.38
Nitrogen,	7.70	7.17	5.68	7.11

5. ANALYSES, ETC. — *Concluded.*

Commercial Fertilizers (Complete).

[I. and II., sent on from Granby, Mass.; III., sent on from Dighton, Mass.; IV., sent on from Concord, Mass.; V., sent on from Hatfield, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	12.81	12.46	8.29	19.76	6.20
Total phosphoric acid,	10.62	9.39	11.85	10.59	2.89
Soluble phosphoric acid,	.26	5.99	6.12	1.97	–
Reverted phosphoric acid,	10.01	2.43	4.61	7.01	1.56*
Insoluble phosphoric acid,	.35	.97	1.13	1.64	1.33
Potassium oxide,	2.78	10.03	10.11	3.78	11.26
Nitrogen,	2.28	3.55	3.69	3.13	4.05

* Available.

Commercial Fertilizers (Complete).

[I., sent on from Hatfield, Mass.; II., sent on from Pittsfield, Mass.; III, sent on from Lancaster, Mass.; IV., sent on from Hatfield, Mass.; V., sent on from East Lexington, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.61	11.07	10.39	6.54	5.36
Total phosphoric acid,	6.75	11.82	10.64	12.62	8.37
Available phosphoric acid,	–*	11.31	8.77	–*	6.91
Insoluble phosphoric acid,	–*	.51	1.87	–*	1.46
Potassium oxide,	9.12	5.26	5.86	11.82	9.44
Nitrogen,	2.60	3.02	2.29	5.42	2.90

* Not determined.

Commercial Fertilizers (Complete).

[I., sent on from East Lexington, Mass.; II., III., IV. and V., sent on from Eastham, Mass.]

	PER CENT.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	5.63	.76	19.76	15.21	9.17
Total phosphoric acid,	5.94	27.12	2.82	.64	14.96
Available phosphoric acid,	4.35	1.40	2.30	.64	14.70
Insoluble phosphoric acid,	1.59	25.72	.52	–	.26
Potassium oxide,	6.08	1.48	9.00	9.32	1.51
Nitrogen,	2.16	.06	1.35	2.18	.09

6. Miscellaneous Analyses.

Cooking Soda.

[Sent on from South Acton, Mass.]

	Per Cent.
Total carbonic acid,	48.25
Available carbonic acid,	15.25
Sulphuric acid,	.31
Hydrochloric acid,	.23
Insoluble matter,	Trace.

Baking Powder.

[Sent on from North Amherst, Mass.]

	Per Cent.
Available carbonic acid,	8.40
Aluminic oxide,	3.49
Phosphoric acid,	4.76
Ammonia,	.75
Sulphuric acid,	5.41
Calcium oxide,	6.08

Soil Deposit.

[Sent on from Shirley, Mass.]

	Per Cent.
Moisture at 100° C.,	6.13
Calcium oxide,	.38
Ferric and aluminic oxides,	.79
Potassium oxide,	.18
Phosphoric acid,	.04
Insoluble matter,	83.18

Soil.

[Sent on from Gardner, Mass.]

	Per Cent.
Moisture at 100° C.,	8.33
Calcium oxide,	.44
Ferric and aluminic oxides,	1.20
Potassium oxide,	.18
Phosphoric acid,	.14
Nitrogen,	.87
Insoluble matter,	58.49

7. Miscellaneous Fodder Analyses.

A. Analyses of Food Articles (Human Food).

Quaker Self-raising Buckwheat Flour.

[Sent on from Ravenna, O.]

	Per Cent.
Moisture at 100° C.,	13.36
Dry matter,	86.64
	100.00

Analysis of Dry Matter.

Crude ash,	5.21
" fibre,	.42
" fat,	.90
" protein,	6.35
Nitrogen-free extract matter,	87.12
	100.00

Hecker's Hominy.

[Sent on from New York, N. Y.]

	Per Cent.
Moisture at 100 C.,	9.56
Dry matter,	90.44
	100.00

Analysis of Dry Matter.

Crude ash,	.22
" fibre,	.45
" fat,	.83
" protein,	9.02
Nitrogen-free extract matter,	89.48
	100.00

Macaroni (Royal Egg Brand).

[Sent on from Minneapolis, Minn.]

	Per Cent.
Moisture at 100° C.,	9.07
Dry matter,	90.93
	100.00

Analysis of Dry Matter.

Crude ash,	–
" fibre,	.34
" fat,	.57
" protein,	12.88
Nitrogen-free extract matter,	86.21
	100.00

Farina (a Wheat Product).

[Sent on from Wilmington, Del.]

	Per Cent.
Moisture at 100° C.,	10.65
Dry matter,	89.35
	100.00

7. Miscellaneous Fodder Analyses — *Continued.*

Analysis of Dry Matter.

	Per Cent.
Crude ash,	.06
" fibre,	.74
" fat,	1.98
" protein,	11.62
Nitrogen-free extract matter,	85.60
	100.00

Condensed Milk.

[No. 1, Milkmaid Brand; No. 2, Eagle Brand.]

	Per Cent.	
	No. 1.	No. 2.
Moisture at 100° C.,	24.48	26.38
Total solids,	75.52	73.62
Fat,	8.95	7.01
Cosein,	9.31	–*
Milk sugar,	13.04	10.04
Cane sugar,	37.43	42.46

Gelatine.

[Sent on from Johnstown, N. Y.]

	Per Cent.			
	No. 1.	No. 2.	No. 3.	Rose-colored.
Moisture at 100° C.,	15.39	15.36	13.94	14.09
Nitrogen,	14.28	14.28	14.68	14.40
Ash,	1.40	1.48	1.88	1.74

*Thacher's Sugar of Milk Baking Powder.**

	Per Cent.
Available carbonic acid,	13.96
Milk sugar,	3.80

Peanut Meal.

[Sent on from Washington, D. C.]

	Per Cent.
Moisture at 100° C.,	8.00
Dry matter,	92.00
	100.00

* Completely soluble in water.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

Analysis of Dry Matter.

	Per Cent.
Crude ash,	4.29
" fibre,	3.76
" fat,	11.69
" protein,	53.26
Nitrogen-free extract matter,	27.00
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	8.00
Potassium oxide,	1.27
Phosphoric acid,	1.54
Nitrogen,	7.84

B. Analyses of Fodder Articles.

The names of the articles described below are those given by the parties sending them for analysis. As the food value of concentrated feed stuffs depends materially on the amount of crude protein and crude fat present, the analysis has been confined in several instances to the determination of these two constituents.

[I., cotton-seed meal, sent on from North Amherst, Mass.; II., cotton-seed meal, sent on from Hatfield, Mass.]

	PER CENT.	
	I.	II.
Moisture at 100° C.,	8.99	9.45
Dry matter,	91.01	90.55
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	7.10	–*
" fibre,	5.53	–*
" fat,	9.66	11.20
" protein,	50.34	40.92
Nitrogen-free extract matter,	27.37	–*
	100.00	–
Fertilizing Constituents.		
Moisture at 100° C.,	8.99	9.45
Phosphoric acid,	–*	3.65
Potassium oxide,	–*	2.34
Nitrogen,	7.33	5.93

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., cotton-seed meal (undecorticated), sent on from Hatfield, Mass.; II., cotton-seed bran, sent on from New York, N. Y.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	10.77	10.10
Dry matter,	89.23	89.90
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	–*	3.58
" fibre,	–*	31.09
" fat,	5.41	3.17
" protein,	23.69	11.82
Nitrogen-free extract matter,	–*	50.34
	–	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	10.77	10.10
Phosphoric acid,	2.04	–*
Potassium oxide,	2.18	–*
Nitrogen,	3.38	1.70

[I., Chicago gluten meal, sent on from Amherst, Mass.; II., Chicago gluten meal, sent on from Boston, Mass.; III., King gluten meal, from station barn.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	9.33	10.22	7.18
Dry matter,	90.67	89.78	92.22
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	.14	–*	1.50
" fibre,	1.73	–*	1.41
" fat,	4.60	8.74	19.68
" protein,	37.09	43.86	38.57
Nitrogen-free extract matter,	56.44	–*	38.84
	100.00	–	100.00

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

Atlas Meal.

[Dry distillery feed, sent on from Peoria, Ill.]

	Per Cent.
Moisture at 100° C.,	11.21
Dry matter,	88.75
	100.00

Analysis of Dry Matter.

Crude ash,	.41
" fibre,	11.94
" fat,	15.28
" protein,	37.30
Nitrogen-free extract matter,	35.07
	100.00

Fertilizing Constituents.

Moisture at 100° C.,	11.21
Potassium oxide,	.16
Phosphoric acid,	.23
Nitrogen,	5.30

This article is new in our market. German experiment station reports speak of two kinds of dry distillery feed, one obtained in connection with the manufacture of alcohol from rye and one from maize; the former contains considerable less crude protein (from twenty-two to thirty per cent.) than the latter (from thirty to thirty-four per cent.).

[I., Buffalo gluten feed, from station barn; II., golden gluten, sent on from Boston, Mass.; III., Chicago maize feed, sent on from Boston, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	8.34	9.89	7.19
Dry matter,	91.66	90.11	92.81
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	.91	–*	1.06
" fibre,	8.61	–*	9.34
" fat,	14.76	15.78	7.39
" protein,	25.09	29.13	27.07
Nitrogen-free extract matter,	50.63	–*	55.14
	100.00	–	100.00

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., gluten feed, sent on from Lincoln, Mass.; II , oil cake, sent on from Boston, Mass.; III., gluten feed, sent on from Lincoln, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	8.52	11.01	8.52
Dry matter,	91.48	88.99	91.48
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	–*	2.35	–*
" fibre,	–*	8.37	–*
" fat,	15.94	18.32	14.58
" protein,	24.21	25.21	22.15
Nitrogen-free extract matter,	–*	45.75	–*
	–	100.00	–

[I., Peoria gluten feed, sent on from Peoria, Ill.; II., Chicago gluten, sent on from Lincoln, Mass.; III., gluten feed, sent on from Lincoln, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	7.07	9.22	9.79
Dry matter,	92.93	90.78	90.21
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	1.16	–*	–*
" fibre,	8.30	–*	–*
" fat,	14.33	8.98	9.07
" protein,	22.71	22.87	21.00
Nitrogen-free extract matter,	53.50	–*	–*
	100.00	–	–

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., combination horse feed, sent on from Amherst, Mass.; II., corn, oats and barley chop, sent on from Springfield, Mass.; III., ground corn and oats chop, sent on from Springfield, Mass.; IV., Iowa gluten meal, sent on from Amherst, Mass.; V., cotton-seed meal, sent on from Amherst, Mass.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	10.84	9.85	7.98	8.31	7.29
Dry matter,	89.16	90.15	92.02	91.69	92.71
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	5.69	4.14	2.35	1.24	7.63
" cellulose,	19.92	8.48	14.62	4.52	5.91
" fat,	1.74	5.54	3.83	10.97	8.41
" protein,	11.22	13.75	9.13	36.40	48.79
Nitrogen-free extract matter,	61.43	68.09	70.07	46.87	29.26
	100.00	100.00	100.00	100.00	100.00

[I., Chicago maize feed, sent on from Boston, Mass.; II., Peoria gluten feed, sent on from Peoria, Ill.; III., Buffalo gluten feed, from station barn; IV., wheat bran, from station barn; V., barley meal, from station barn.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.19	7.07	9.37	9.15	11.17
Dry matter,	92.81	92.93	90.63	90.85	88.83
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	1.06	1.16	.86	6.10	2.79
" cellulose,	9.34	8.30	8.17	11.06	8.03
" fat,	7.39	14.33	14.71	6.10	2.51
" protein,	27.07	22.71	23.16	18.29	9.99
Nitrogen-free extract matter,	55.14	53.50	53.10	58.45	76.68
	100.00	100.00	100.00	100.00	100.00

7. Miscellaneous Fodder Analyses — *Continued.*

[I. and II., cotton-seed meal, sent on from Longmeadow, Mass.; III., cotton-seed meal, sent on from Williamsburg, Mass.; IV., Chicago germ feed, sent on from Weston, Mass.; V., oat feed, sent on from North Amherst, Mass.: VI., ground oats, sent on from North Amherst, Mass.]

	Per Cent.					
	I.	II.	III.	IV.	V.	VI.
Moisture at 100° C.,	5.87	5.82	6.35	7.35	6.75	8.89
Dry matter,	94.13	94.18	93.65	92.65	93.25	91.11
	100.00	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.						
Crude fat,	11.55	10.85	9.30	13.18	4.83	4.52
" protein,	50.19	47.78	51.38	11.06	11.93	11.93

[I., gluten feed, sent on from Lincoln, Mass.; II., gluten feed, sent on from Lincoln, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	8.52	8.61
Dry matter,	91.48	91.39
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	–*	–*
" fibre,	–*	–*
" fat,	14.59	12.70
" protein,	22.15	16.81
Nitrogen-free extract matter,	–*	–*

* Not determined.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., peanut cake (Germany); II., peanut husks from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C,	–	12.98
Dry matter,	–	87.02
	–	100.00
Analysis of Dry Matter.		
Crude ash,	–	1.36
" fibre,	–	75.91
" fat,	8—12	1.90
" protein,	42—52	5.74
Nitrogen-free extract matter,	–	15.09
	–	100.00
Fertilizing Constituents.		
Moisture at 100° C,	–	12.98
Phosphoric acid,	–	.13
Potassium oxide,	–	.48
Nitrogen,	6—8	.80

[I., Peoria gluten feed, sent on from North Amherst, Mass.; II., King gluten meal, sent on from New York, N. Y.; III., Iowa gluten meal, sent on from Beverly, Mass.; IV., rye feed, sent on from Westborough, Mass.; V., oat feed, from station barn.]

	Per Cent.				
	I.	II.	III.	IV.	V.
Moisture at 100° C.,	7.50	6.65	7.33	8.23	6.50
Dry matter,	92.50	93.35	92.67	91.77	93.50
	100.00	100.00	100.00	100.00	100.00
Analysis of Dry Matter.					
Crude ash,	.90	2.19	–*	3.34	10.02
" cellulose,	8.86	1.62	–*	3.62	17.73
" fat,	13.62	21.44	16.08	3.04	3.95
" protein,	21.35	36.19	31.56	16.62	11.02
Nitrogen-free extract matter,	55.27	38.56	–*	73.38	57.28
	100.00	100.00	–	100.00	100.00

* Not determined.

7. MISCELLANEOUS FODDER ANALYSES — *Continued.*

[I., peanut feed, sent on from Granby, Mass.; II., peanut feed, sent on from Boston, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	9.08	10.92
Dry matter,	90.92	89.08
	100.00	100.00
Analysis of Dry Matter.		
Crude ash,	2.25	3.60
" fibre,	62.48	62.82
" fat,	7.61	4.49
" protein,	10.31	9.54
Nitrogen-free extract matter,	17.35	19.55
	100.00	100.00
Fertilizing Constituents.		
Moisture at 100° C.,	9.07	10.92
Phosphoric acid,	.23	–*
Potassium oxide,	.79	–*
Nitrogen,	1.50	1.36

[I., meat meal, sent on from New York; II., German analysis, sent on.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	8.00	–
Dry matter,	92.00	–
	100.00	–
Analysis of Dry Matter.		
Crude ash,	–*	–
" fibre,	–*	–
" fat,	20.73	12.70
" protein,	76.15	73.50
Nitrogen-free extract matter,	–*	–
Fertilizing Constituents.		
Moisture at 100° C.,	8.00	–
Phosphoric acid,	.73	–
Potassium oxide,	.30	–
Nitrogen,	11.21	11.70

* Not determined.

This meal is a refuse from the manufacture of Liebig's extract of meat. In the process of manufacture it has lost its salines, and in feeding the meal these are replaced in the form of chemicals.

7. Miscellaneous Fodder Analyses — *Continued.*

[I., late soja bean, station, cut July 10, 1893, twelve to thirteen inches high, not in bloom; II., early black soja bean, station, cut July 10, 1893, sixteen to seventeen inches high, on point of blooming; III., early white soja bean, station, cut July 10, 1893, fourteen inches high, just before blooming; IV., early white soja bean, station. cut July 10, 1893, sixteen to seventeen inches high, before blooming.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	77.09	82.21	79.51	74.97
Dry matter,	22.91	17.79	20.49	25.03
	100.00	100.00	100.00	100.00
Analysis of Dry Matter.				
Crude ash,	14.36	12.86	14.36	11.85
" cellulose,	16.47	25.06	23.41	23.23
" fat,	3.34	3.38	2.97	2.16
" protein,	22.16	16.18	14.34	13.81
Nitrogen-free extract matter,	43.67	42.52	44.92	48.95
	100.00	100.00	100.00	100.00
Total nitrogen,	3.54	2.59	2.29	2.21
Amide nitrogen,	.79	.55	.68	.31

[I., rowen from station barn; II., carrots, raised on station grounds; III., beets, raised on station grounds.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	18.64	88.01	83.71
Dry matter,	81.36	11.99	16.29
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	7.62	7.98	6.79
" cellulose,	26.09	9.00	5.84
" fat,	3.28	2.03	.71
" protein,	14.42	7.29	13.27
Nitrogen-free extract matter,	48.59	73.70	73.39
	100.00	100.00	100.00
Fertilizing Constituents.			
Moisture at 100° C.,	18.640	88.010	83.710
Potassium oxide,	1.682	.441	.463
Phosphoric acid,	.574	.095	.111
Nitrogen,	1.876	.140	.346
Insoluble matter,	1.533	.029	.111

7. Miscellaneous Fodder Analyses — *Concluded.*

[I., potatoes, station, raised on Plat 1, Field C, with muriate of potash; II., potatoes, station, raised on Plat 4, Field C, with sulphate of potash; III., potatoes from station barn.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	80.71	81.17	78.67
Dry matter,	19.29	18.83	21.33
	100.00	100.00	100.00
Analysis of Dry Matter.			
Crude ash,	4.71	4.64	4.76
" fibre,	2.26	2.35	2.30
" fat,	.54	.42	.62
" protein,	10.98	10.06	9.56
Nitrogen-free extract matter,	81.51	82.53	82.76
	100.00	100.00	100.00
Starch,	13.44	13.15	–*
Starch in dry matter,	69.66	70.31	–*
Fertilizing Constituents.			
Moisture at 100° C.,	80.710	81.170	78.670
Calcium oxide,	.018	.020	–*
Magnesium oxide,	.044	.041	–*
Potassium oxide,	.607	.553	.589
Sodium oxide,	.029	.024	–*
Phosphoric acid,	.065	.048	.134
Nitrogen,	.338	.303	.326
Insoluble matter,	.026	.048	.036

* Not determined.

Apple Pomace.

[Sent on from Sherborn, Mass.]

	Per Cent.
Moisture at 100° C.,	87.51
Dry matter,	12.49
	100.00
Analysis of Dry Matter.	
Crude ash,	3.36
" fibre,	21.67
" fat,	5.93
" protein,	5.75
Nitrogen-free extract matter,	63.29
	100.00

C. Discussion on Commercial Feed Stuffs.

BY C. A. GOESSMANN.

The name commercial feed stuff or concentrated commercial feed stuffs is usually applied to a class of substances offered for sale in our markets which, in the majority of cases, are the waste or by-products of other branches of industry. Some of these articles, as brans, middlings and oil cakes, have been for years quite generally used in the daily diet of all kinds of farm live stock; others, as the gluten meal, gluten feed, corn germ meal, dried brewers' grain, malt sprouts, dry distillery feed, etc., have been but recently more generally offered for a similar purpose.

Their importance as an additional valuable fodder supply for the support of every branch of animal industry on the farm and elsewhere has become from year to year more conspicuous, on account of a marked increase of the supply of well-known articles, as well as of the introduction of many new kinds. Their consumption is apparently daily increasing, and seems to keep step with the supply.

The special value claimed for commercial feed stuffs as an important source of fodder supply rests in the main on their fitness to supplement advantageously our coarse home-raised fodder crop in the interest of a higher feeding effect and of a better economy. A frequently good mechanical condition, as well as an exceptionally valuable chemical composition, adapt many of them in a high degree for that purpose.

As no single farm crop or any part of it has been found to supply economically and efficiently to any considerable extent the particular wants of food of our various kinds of farm live stock, to secure the best possible results, it becomes a matter of first importance from a mere financial stand-point to know how to supplement our current farm crops to meet the wants of each kind of animals under various circumstances in a desirable degree. To secure the highest feeding effect of each fodder article raised upon the farm is most desirable in the interest of good economy.

Practical experience in the dairy has thus far abundantly shown that the efficiency of a daily diet does not so much

depend on the mere use of more or less of one or the other reputed fodder article as on the presence of suitable fodder articles which contain the *three essential groups of food constituents*, i. e., *organic nitrogenous, non-nitrogenous and mineral constituents of plants*, in a desirable form, and in such relative proportions and quantities as have been recognized to be necessary to meet efficiently the food supply of the dairy cow. Similar relations are known to exist in regard to the diet best adapted in case of all kinds of animals. *An economical system of stock feeding has to select among the suitable fodder articles those which furnish the required quality and proportion of the three recognized essential food constituents in a digestible form, at the lowest cost.*

Actual observations in stock feeding fully confirm the correctness of the above statement, that a judicious selection from among the current commercial feed stuffs, for the purpose of serving in connection with one or more of our home-raised fodder plants as a fodder ingredient of the daily diet, does, as a rule, tend not only to improve their food value, but also lowers in the majority of cases the net cost of the feed consumed. For more details regarding the determination of the intrinsic value of fodder rations I have to refer on the present occasion, for obvious reasons, to preceding annual reports.

The majority of commercial feed stuffs occupy in a rational system of stock feeding a similar position to our home-raised fodder crops as is commonly conceded to the commercial fertilizer with reference to the barn-yard manure for the production of farm crops; they serve for the preparation of a complete diet under different conditions and for different purposes. The individual merits of each of them become in the same degree better appreciated as the principles which govern animal nutrition are *more generally* understood, and *find a due recognition* in our modes of compounding the daily diet for different kinds as well as for different conditions of the same kind of animals. *They are as a class to-day considered indispensable for a remunerative management of every branch of animal industry on the farm and elsewhere.*

Many of the commercial feed stuffs contain, aside from a liberal amount of phosphoric acid and potash, an exception-

ally large percentage of nitrogen. This circumstance gives them a special claim, independent of their respective food value for animals. A liberal addition of these feed stuffs to the daily diet of any kind of animal imparts to the manurial refuse resulting from their use a corresponding higher commercial and agricultural value as a valuable source of plant food. A judicious and liberal introduction of a quite numerous class of commercial feed stuffs into the daily fodder supply of the animals kept on the farm is for this reason *deservedly* recommended as a safe and economical way to increase the home production of plant food in the interest of an increase in the fertility of the farm lands.

As the financial success of a mixed system of farming in particular depends to a considerable degree on the character, the amount and the cost of production of the manurial refuse secured in connection with the special farm industry carried on at the time, it seems to need no further argument to prove that the relation which exists between the temporary *market cost* of the particular feed stuff under consideration and the *market value* of the manurial elements which it contains deserves a serious consideration when devising an efficient and at the same time an economical diet.

The character and commercial value of the manurial refuse obtainable from any kind of feed stuff, under otherwise corresponding conditions, stand in a direct relation to more or less of the different essential fertilizing constituents — phosphoric acid, potash and, in particular, nitrogen — it contains. The commercial value of these three important articles of plant food found frequently in prominent commercial feed stuffs equals in many instances more than one-half of the market cost of the particular fodder ingredient in question.

The subsequent tabular statement may serve as an illustration of these relations between market cost and fertilizing value of some current reputed fodder articles: —

NAME OF FEED STUFFS.	Market Cost (per Ton).	Manurial Value (per Ton).
Corn meal,	$24 00	$7 31
Gluten meal (Chicago),	28 00	14 72
Chicago maize feed,	25 00	13 25
Buffalo gluten feed,	23 00	12 57
Cotton-seed meal,	28 00	23 52
Linseed meal (old process),	26 00	19 22
Linseed meal (new process),	27 00	20 37
Wheat middlings,	17 00	9 50
Wheat bran,	17 00	13 23
Dried brewers' grain,	23 00	9 96
English hay (first cut of meadows),	15 00	5 92
Rowen (second cut of meadows),	15 00	7 00
Corn fodder,	7 00	4 55
Corn stover,	5 00	3 75
Corn ensilage,	2 50	1 53
Sugar beets,	5 00	1 21
Mangold roots,	4 00	1 01

The above-stated market cost is subject to periodical changes, and the commercial value of their fertilizing constituents varies more or less with the quality of each kind. This feature does not affect materially the force of the point made.

A due appreciation of the previously pointed out favorable features regarding the peculiar character of a numerous class of commercial feed stuffs has caused a steady increase in their consumption on the farm and elsewhere. *The money invested by farmers for securing commercial feed stuffs as an additional food supply for home consumption exceeds to-day many times the amount spent for commercial fertilizers.*

As no single commercial feed stuff can be expected to meet our present demand for these articles, nor can claim to be the most economical one under varying market conditions, and with due appreciation of the varying character of our home-raised fodder supply, it is but proper that every new addition in suitable kinds should receive a deserved attention, and subsequently an actual trial to ascertain its individual merits.

A considerable number of these feed stuffs has already been tried at this station during past years, in connection with our feeding experiments with milch cows, growing

steers, lambs and pigs, as may have been noticed in our periodical reports; others are at present on trial.

Commercial feed stuffs are usually bought for their high percentage of either nitrogen-containing organic matter or fat, or both. They are used to enrich the daily diet of various kinds of farm live stock in both directions. This course is generally adopted on account of a well-known deficiency of most of our home-raised coarse fodder articles in regard to both food constituents, in particular, of nitrogenous matter. Farmers that do not raise a liberal proportion of clover-like fodder plants are in a particular degree in need of concentrated commercial feed stuffs rich in nitrogenous food constituents to turn the excess of the non-nitrogenous food constituents which most of our current home-raised coarse fodder articles contain to the best possible account.

The liability of pecuniary losses on the part of the buyer, in consequence of exceptional variations in the percentage of nitrogenous organic matter, crude protein or fat, or of both, is quite frequently greatly aggravated by most unexpected serious fluctuations in the market cost of leading feed stuffs.

As we buy in the majority of cases the concentrated commercial feed stuffs on account of their large proportion of nitrogen-containing food constituents, it becomes of special interest to know at what cost *a given quantity of nitrogen-containing food constituents* can be bought in the form of different feed stuffs equally well adapted under existing circumstances. A change in the *market cost* of one and the same commercial feed stuff affects the cost of the nitrogen-containing food constituent in particular, as its supply is more limited than that of the non-nitrogenous food constituents which our home-raised coarse fodder articles contain, as a rule, in abundance, and which, therefore, need not be secured from outside resources for cash.

The subsequent tabular statement assumes a constant cost of digestible non-nitrogenous food constituents, — sugar, starch, fat, etc., — and shows thereby the variations in the cost of digestible nitrogen-containing food constituents in case of some prominent concentrated commercial feed stuffs in our local market.

The majority of analyses stated are made of fodder articles which have been used either during the past years in connection with some of our feeding experiments, or have been raised upon the grounds of the station. Some articles sent on by outside parties are added, on account of the special interest they may present to others.

Valuation of Fodder Articles on the Following Basis.

[Digestible cellulose and nitrogen-free extract matter, 1 cent per pound; digestible fat, 2½ cents per pound. The value of digestible protein determined the difference of the sum of both and the market cost of the fodder articles. (Calculation is based on dry matter, 2,000 pounds.)]

	Market Cost.	Protein per Pound (Cents).
Corn meal,	$31 00	6.88
Corn meal,	29 00	5.84
Corn meal,	24 00	3.24
Corn meal,	23 00	2.72
Wheat middlings,	20 00	3.13
Spring wheat bran,	19 00	3.04
Winter wheat bran,	21 00	3.93
Chicago maize feed,	23 00	2.34
Dried brewers' grain,	22 00	3.37
Old-process linseed meal,	26 00	2.20
New-process linseed meal,	27 00	2.68
Chicago gluten meal,	28 00	2.46
Cotton-seed meal,	28 00	2.34
English hay,	12 00	1.36
English hay,	15 00	4.12
Rowen,	12 00	1.21
Rowen,	15 00	3.24
Corn stover,*	5 00	–
Corn ensilage,*	2 50	–
Mangold roots,*	3 00	–
Sugar beets,*	5 00	–

* The value of the digestible cellulose, nitrogen-free extract matter and fat, on the above basis, exceeds the market cost.

The present condition of the trade in commercial concentrated feed stuffs deserves the serious attention of dealers and consumers for the following reasons: —

Prices are apt to rise and to fall without any reference to the agricultural value of the article in question.

Names may remain the same, and in fact do remain in some instances, while the composition of the article suffers

serious changes in consequence of changes in the parent industry.

Sales without due responsibility regarding the particular quality of the goods delivered leave the pecuniary risk involved in the transaction in an objectionable degree on the side of the buyer.

Unaccounted-for variations in the composition of feed stuffs must prove a serious obstacle in the desirable introduction of a rational and economical system of stock feeding.

For these and other reasons previously pointed out it cannot be claimed that the prevailing mode of selling and buying commercial feed stuffs rests on a just and fairly equitable basis.

The trade in commercial feed stuffs is to-day in a similar unsatisfactory condition as was the trade in commercial fertilizers before the introduction of a system of State inspection in regard to those articles.

The best interests of both manufacturers and farmers, in fact of every one who keeps live stock for his accommodation, render such changes desirable in the present mode of selling and buying feed stuffs as will impose mutual and equitable responsibility on all parties interested in the transaction. The limited margins for profit in every branch of animal industry carried on at our farms necessitate a careful attention to all the details of the business. The money interests involved are of an exceptional magnitude.

II.

Analyses of Milk sent on for Examination.

[Per Cent.]

Number of Samples.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
1, . .	12.50	3.69	8.81	Northborough.	
2, . .	12.13	4.27	7.86	Westborough.	
3, . .	12.19	4.50	7.69	Westborough.	
4, . .	11.62	4.25	7.37	Westborough.	
5, . .	12.20	3.39	8.81	Westborough.	
6, . .	13.18	4.23	8.95	Westborough.	
7, . .	12.55	3.36	9.05	New Braintree.	
8, . .	12.78	4.05	8.73	Westborough.	
9, . .	14.31	5.03	9.28	North Amherst.	
10, . .	12.85	3.51	9.34	Barre.	
11, . .	10.20	2.10	8.10	Barre.	
12, . .	12.12	3.64	8.48	Barre.	
13, . .	12.50	3.71	8.89	Barre.	
14, . .	12.61	3.71	8.90	Barre.	
15, . .	13.04	4.19	8.85	Barre.	
16, . .	11.54	3.42	8.12	Barre.	
17, . .	12.71	3.82	8.89	New Braintree.	
18, . .	12.10	3.25	8.85	New Braintree.	
19, . .	10.76	2.13	8.63	New Braintree.	
20, . .	11.15	2.88	8.27	New Braintree.	
21, . .	12.18	3.55	8.63	New Braintree.	

ANALYSES OF MILK SENT ON FOR EXAMINATION — *Concluded.*

Number of Samples.	Solids.	Fat.	Solids not Fat.	Locality.	Remarks.
22, . .	13.30	3.65	9.65	New Braintree.	
23, . .	12.52	3.18	9.34	New Braintree.	
24, . .	12.59	3.68	8.91	New Braintree.	
25, . .	13.78	4.37	9.41	New Braintree.	
26, . .	13.39	4.13	9.26	New Braintree.	
27, . .	10.99	2.50	8.49	Westborough.	
28, . .	11.38	3.00	8.38	Westborough.	
29, . .	11.53	3.00	8.53	Westborough.	
30, . .	10.63	2.10	8.53	Westborough.	
31, . .	11.14	2.90	8.24	Westborough.	
32, . .	12.03	3.30	8.73	Westborough.	
33, . .	13.01	4.60	8.41	Westborough.	
34, . .	11.08	2.80	8.28	Westborough.	
35, . .	11.68	3.20	8.48	Westborough.	
36, . .	12.90	3.60	9.30	Barre Plains.	
37, . .	17.20	7.90	9.30	Norton.	
38, . .	12.83	4.06	8.77	Barre Plains.	
39, . .	12.14	3.66	8.48	Gilbertville.	
40, . .	12.25	3.61	8.64	Barre Plains.	

III.

Analyses of Water sent on for Examination.*

[Parts per million.]

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
1	.040	.112	3.00	3.25	176.00	56.00	–	Concord.
2	.036	.184	8.00	2.21	104.00	28.00	–	Northborough.
3	.056	.112	6.00	.79	116.00	32.00	–	Northborough.
4	.012	.028	2.00	1.82	104.00	86.00	–	Leverett.
5	.180	.234	6.00	.71	62.00	28.00	–	Barre.
6	.024	.104	25.00	9.71	330.00	134.00	–	Barre.
7	.068	.148	41.00	11.35	484.00	166.00	–	Barre.
8	.066	.194	14.00	3.51	156.00	44.00	–	Barre.
9	Trace.	.134	13.00	4.43	186.00	94.00	–	Weston.
10	.134	.144	5.00	.56	50.00	16.00	–	Barre.
11	.030	.060	5.00	.24	46.00	12.00	–	Barre.
12	.176	.100	104.00	7.14	380.00	168.00	–	Amherst.
13	.040	.088	8.00	1.56	108.00	60.00	None.	Amherst.
14	.056	.152	6.00	3.25	188.00	92.00	–	Amherst.
15	.048	.088	9.00	.16	84.00	28.00	–	Northfield.
16	.072	.096	20.80	4.57	160.00	64.00	–	Northfield.
17	.044	.096	13.00	2.86	164.00	68.00	–	Littleton.
18	.038	.044	4.00	.32	56.00	16.00	–	Holyoke.
19	.044	.036	4.00	–	80.00	24.00	–	Holyoke.
20	.072	.080	6.00	.16	60.00	36.00	–	Holyoke.
21	.084	.080	26.00	4.16	80.00	32.00	–	Westminster.
22	.060	.020	5.00	10.35	292.00	148.00	–	Springfield.
23	Trace.	Trace.	5.00	5.43	196.00	124.00	–	Springfield.
24	.016	.012	5.00	11.80	300.00	150.00	–	Springfield.
25	.022	.012	20.00	2.60	112.00	20.00	–	North Amherst.

* Analysis of well water at the station is confined to chemical tests with reference to an excess of foreign matter from sinks, barns, etc.

ANALYSES OF WATER, ETC. — *Continued.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
26	.008	.008	7.00	5.43	118.00	48.00	–	Leverett.
27	.024	.052	4.00	1.95	52.00	32.00	–	South Deerfield.
28	.024	.040	12.00	1.82	94.00	40.00	–	Weston.
29	.020	.036	10.00	1.82	–	–	–	Weston.
30	1.000	.920	24.00	7.02	308.00	104.00	–	South Deerfield.
31	.440	.208	10.00	3.12	140.00	68.00	–	Littleton.
32	.296	.184	14.00	1.69	130.00	40.00	–	Littleton.
33	.036	.136	6.00	.49	144.00	60.00	–	Littleton.
34	.160	.288	40.00	9.71	470.00	168.00	–	Lancaster.
35	.116	.128	8.00	2.21	78.00	46.00	–	New Braintree.
36	.012	.148	6.00	1.43	62.00	20.00	–	New Braintree.
37	.016	.180	12.00	2.21	96.00	12.00	–	Brockton.
38	.312	.360	14.00	3.64	176.00	74.00	–	East Lexington.
39	.120	.116	6.00	1.11	55.84	–	–	Lowell.
40	.020	.384	6.00	1.11	90.00	26.00	–	Springfield.
41	.128	.520	6.00	.95	76.00	20.00	–	Springfield.
42	.032	.168	4.00	1.95	80.00	26.00	–	Amherst.
43	.020	.108	5.00	.95	140.00	60.00	–	Hadley.
44	.024	.102	8.00	1.95	104.00	48.00	–	Amherst.
45	.024	.180	10.00	1.95	–	–	–	Amherst.
46	.008	.096	4.00	.95	72.00	24.00	None.	Amherst.
47	.004	.092	4.00	.95	80.00	28.00	–	Amherst.
48	.016	.086	7.00	2.21	112.00	52.00	–	Kendall Green.
49	.008	.060	6.00	1.95	112.00	52.00	–	Kendall Green.
50	.016	.144	4.00	1.95	104.00	28.00	–	Kendall Green.
51	.144	.264	8.00	–	100.00	20.00	–	Pelham.
52	.036	.204	6.00	–	–	–	–	Pelham.
53	.016	.192	4.00	–	–	–	–	Pelham.
54	.032	.068	22.00	–	–	–	–	Amherst.
55	.060	.096	4.00	4.86	76.00	24.00	–	Greenfield.
56	.300	–	12.00	–	–	–	–	Amherst.
57	.076	.084	96.00	–	–	–	–	Amherst.
58	.008	.068	40.00	–	–	–	–	Hadley.
59	.120	–	8.00	–	–	–	–	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
60	.028	.152	18.00	–	–	–	Present.	Amherst.
61	.036	.084	34.00	–	–	–	–	Amherst.
62	None.	.040	12.00	4.03	–	–	–	Amherst.
63	.076	.496	18.00	–	–	–	–	Amherst.
64	.024	.092	20.00	–	–	–	–	Amherst.
65	.028	.124	7.00	–	–	–	–	Amherst.
66	.024	.244	8.00	–	–	–	–	Amherst.
67	.072	.064	14.00	5.14	196.00	64.00	–	Springfield.
68	.040	.308	4.00	.48	160.00	60.00	–	Springfield.
69	None.	.092	6.00	–	–	–	–	Amherst.
70	.096	.112	8.00	–	–	–	–	Amherst.
71	.022	.242	8.00	–	–	–	–	South Deerfield.
72	.212	.108	6.00	5.29	–	–	–	Lawrence.
73	.088	.232	8.00	2.99	–	–	–	Lawrence.
74	.144	.184	12.00	2.99	–	–	–	Lawrence.
75	.024	.092	36.00	–	–	–	–	Amherst.
76	.010	.162	5.00	–	–	–	–	Pelham.
77	.004	.044	7.00	–	–	–	–	Medway.
78	None.	.072	48.00	4.29	–	–	–	Worcester.
79	Trace.	.082	16.00	–	–	–	–	Amherst.
80	1.840	–	16.00	–	–	–	–	Amherst.
81	.012	.448	4.00	.95	134.00	30.00	–	Pelham.
82	.040	.188	14.00	–	–	–	–	Amherst.
83	.016	.320	12.00	4.57	–	–	–	Amherst.
84	.008	.184	4.00	.95	–	–	–	Amherst.
85	.006	.040	7.00	1.69	46.00	4.00	–	Worcester.
86	.348	.128	6.00	1.27	29.00	8.00	–	Weston.
87	.032	.136	20.00	3.51	174.00	40.00	–	Dighton.
88	.108	.920	19.00	6.29	280.00	80.00	–	Templeton.
89	.076	.104	60.00	4.29	–	–	–	Amherst.
90	.120	.064	10.00	6.71	–	–	None.	Amherst.
91	.024	.068	7.00	–	–	–	–	North Amherst.
92	.044	.148	10.00	–	–	–	–	North Amherst.
93	.016	.164	15.00	–	–	–	–	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
94	.240	.120	10.00	-	-	-	-	South Deerfield.
95	.540	.440	16.00	-	-	-	-	Amherst.
96	.044	.080	12.00	-	-	-	-	Amherst.
97	.465	.210	4.00	-	-	-	-	Amherst.
98	.012	.176	22.00	5.43	272.00	36.00	-	Springfield.
99	.120	.056	18.00	-	-	-	-	Amherst.
100	Trace.	.072	27.00	-	-	-	-	Amherst.
101	Trace.	.100	86.00	10.00	-	-	-	Amherst.
102	.032	.120	21.00	6.43	-	-	-	Amherst.
103	.052	.061	14.00	2.60	-	-	-	Amherst.
104	.064	.042	10.00	1.43	132.00	60.00	-	Barre.
105	.072	.152	12.00	2.21	-	-	-	Methuen.
106	.016	.088	9.00	2.73	-	-	-	Amherst.
107	.004	.250	16.00	2.34	-	-	-	Amherst.
108	.380	.260	31.00	-	-	-	-	Amherst.
109	.460	-	19.00	-	-	-	-	Amherst.
110	.010	.248	4.00	-	96.00	24.00	-	Pelham.
111	Trace.	.070	20.00	5.29	-	-	-	Amherst.
112	None.	.110	13.00	-	-	-	-	Amherst.
113	.074	.106	37.00	10.30	-	-	-	Newburyport.
114	2.300	-	34.00	-	-	-	-	Amherst.
115	.024	.108	51.00	-	-	-	-	Amherst.
116	.044	.072	6.00	-	-	-	None.	North Amherst.
117	.072	.172	6.00	-	-	-	-	Petersham.
118	.030	.150	8.00	.95	-	-	-	Amherst.
119	.024	.178	5.00	.79	-	-	-	Coldbrook Springs.
120	.004	.044	12.00	-	-	-	None.	Amherst.
121	.016	.140	7.00	4.29	-	-	-	Amherst.
122	.012	.074	16.00	2.08	140.00	42.00	-	Amherst.
123	.048	.068	4.00	-	-	-	-	Leverett.
124	.008	.064	9.00	-	-	-	-	Amherst.
125	.004	.064	6.00	-	-	-	-	Amherst.
126	.008	.056	10.00	-	-	-	-	Berlin.
127	.046	.164	30.00	-	226.00	76.00	-	Amherst.

ANALYSES OF WATER, ETC. — *Continued.*

NUMBER.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
128	.120	.190	12.00	–	–	–	–	Amherst.
129	Trace.	.076	8.00	–	–	–	–	Amherst.
130	.020	.100	6.00	–	–	–	–	Petersham.
131	.108	.264	9.00	–	–	–	–	South Amherst.
132	Trace.	.253	5.00	–	–	–	–	Holyoke.
133	Trace.	.070	8.00	–	–	–	–	Amherst.
134	None.	.084	10.00	–	–	–	–	Amherst.
135	.060	.040	9.00	3.77	–	–	–	Westford.
136	.680	.350	9.00	5.57	–	–	–	Westford.
137	.016	.116	10.00	–	–	–	–	Amherst.
138	.200	.152	16.00	–	–	–	–	Amherst.
139	.076	.312	7.00	–	–	–	–	Northborough.
140	.084	.240	6.00	1.11	78.00	46.00	–	Pelham.
141	.016	.385	20.00	–	–	–	–	East Lexington.
142	.008	.054	9.00	2.99	–	–	–	Amherst.
143	None.	.020	7.00	.48	–	–	–	Amherst.
144	.080	.060	9.00	1.82	–	–	–	Amherst.
145	.014	.026	8.00	.48	–	–	Present.	North Brookfield.
146	.008	.088	12.00	–	–	–	–	Amherst.
147	Trace.	.352	8.00	–	–	–	Present.	Amherst.
148	.136	.224	18.00	6.86	–	–	–	Amherst.
149	.012	.120	10.00	4.03	160.00	58.00	–	North Hadley.
150	.008	.188	16.00	7.43	238.00	104.00	–	Williamsburg.
151	.068	.100	4.00	1.95	84.00	12.00	–	Westhampton.
152	.012	.240	4.00	.56	70.00	20.00	–	Amherst.
153	.622	–	166.00	–	–	–	–	North Hadley.
154	.128	.208	5.00	–	–	–	–	Monterey.
155	.040	.264	3.00	–	–	–	–	Amherst.
156	.024	.264	3.00	–	–	–	–	Amherst.
157	.012	.072	9.00	2.73	88.00	20.00	–	Chelmsford.
158	–	.200	5.00	–	74.00	20.00	–	Amherst.
159	.176	.192	5.00	.79	76.00	12.00	–	Amherst.
160	.072	.076	50.00	9.14	274.00	104.00	–	North Andover.
161	.040	.208	8.00	–	–	–	–	West Acton.

Analyses of Water, etc. — *Continued.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
162	.012	.180	4.00	-	60.00	22.00	-	Northfield.
163	.304	.184	6.00	-	60.00	22.00	-	Northfield.
164	.060	.096	4.00	4.86	76.00	24.00	-	Greenfield.
165	.040	.076	3.50	2.73	70.00	22.00	-	Greenfield.
166	.256	.072	18.00	3.51	166.00	32.00	-	Boston.
167	.036	.064	7.00	2.73	120.00	34.00	-	Boston.
168	.208	.176	5.00	.48	78.00	-	-	Amherst.
169	.208	.192	5.00	.48	80.00	20.00	-	Amherst.
170	.010	.214	4.00	.48	60.00	24.00	-	Amherst.
171	.028	.184	5.00	2.21	70.00	39.00	-	Greenfield.
172	.016	.144	4.00	3.90	104.00	64.00	-	Greenfield.
173	.036	.080	5.00	1.69	54.00	16.00	-	Greenfield.
174	.112	.080	7.00	-	-	-	-	Amherst.
175	.008	.120	11.00	3.25	124.00	38.00	-	Amherst.
176	None.	.092	18.00	5.14	246.00	96.00	-	Amherst.
177	Trace.	.252	8.00	4.29	128.00	76.00	-	Amherst.
178	.068	.160	26.00	-	-	-	-	North Amherst.
179	.064	.100	4.00	-	-	-	-	North Amherst.
180	-	-	-	4.03	138.00	90.00	-	Amherst.
181	.058	.088	21.00	9.43	270.00	112.00	-	Westford.
182	.050	.036	15.00	10.90	264.00	134.00	-	Westford.
183	.016	.248	5.00	.80	76.00	24.00	-	Amherst.
184	.012	.236	6.00	.80	76.00	20.00	-	Amherst.
185	.024	.120	6.00	4.29	384.00	60.00	-	Amherst.
186	.024	.032	8.00	2.73	96.00	36.00	-	Amherst.
187	.020	.108	28.00	2.21	184.00	48.00	-	Amherst.
188	.080	.220	12.00	1.69	84.00	28.00	-	South Framingham.
189	Trace.	.064	18.00	7.14	312.00	72.00	-	South Framingham.
190	.020	.128	8.00	2.73	68.00	28.00	-	South Framingham.
191	None.	.140	14.00	4.03	172.00	52.00	-	Amherst.
192	.016	.152	16.00	4.03	212.00	36.00	-	Amherst.
193	.012	.068	6.00	5.14	148.00	48.00	-	North Wilbraham.
194	.020	.136	32.00	6.29	260.00	92.00	-	North Amherst.
195	.148	.200	42.00	9.71	360.00	116.00	-	North Amherst.

ANALYSES OF WATER, ETC. — *Concluded.*

Number.	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Hardness (Clark's Degree).	Solids at 100° C.	Solids at Red Heat.	Lead.	Locality.
196	.100	.096	4.00	.48	48.00	24.00	–	Westford.
197	.048	.084	4.00	–	68.00	36.00	–	Amherst.
198	.036	.056	12.00	–	196.00	40.00	–	Amherst.
199	.012	.024	4.00	1.43	68.00	28.00	–	Amherst.
200	.156	.060	10.00	–	–	–	–	Amherst.

The analyses have been made according to Wancklyn's process, familiar to chemists, and are directed towards the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals, lead in particular. (For a more detailed description of this method, see "Water Analyses," by J. A. Wancklyn and E. T. Chapman.)

Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water, without chlorine, indicates a vegetable source of contamination.

3. More than five grains per gallon* of chlorine (=71.4 parts per million), accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight-hundredths parts per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia, over .15 parts per million, ought to absolutely condemn a water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon (571.4 parts per million).

* One gallon equals 70,000 grains.

An examination of the previously stated analyses indicates that Nos. 2, 5, 7, 8, 14, 30, 31, 32, 34, 36, 37, 38, 40, 41, 42, 51, 52, 53, 56, 57, 59, 60, 63, 66, 68, 71, 72, 73, 74, 76, 80, 81, 82, 83, 84, 86, 88, 92, 93, 94, 95, 97, 98, 105, 107, 108, 109, 110, 114, 117, 118, 119, 127, 128, 131, 132, 136, 138, 139, 140, 141, 147, 148, 150, 153, 154, 155, 156, 158, 159, 161, 162, 163, 168, 170, 171, 177, 178, 183, 184, 188, 192 and 195 ought to be condemned as unfit for family use; while Nos. 1, 3, 6, 9, 10, 12, 15, 16, 17, 20, 33, 35, 39, 43, 44, 45, 46, 47, 48, 50, 55, 61, 64, 65, 67, 70, 75, 78, 79, 87, 89, 90, 96, 99, 101, 102, 104, 112, 113, 115, 121, 130, 137, 149, 151, 152, 160, 164, 166, 172, 174, 175, 179, 185, 187, 190, 191, 194, 196 and 200 must be considered suspicious.

Parties sending on water for analysis ought to be very careful to use clean vessels, clean stoppers, etc. The samples should be sent on without delay after collecting. One-half gallon is desirable for the analysis.

The examinations of water, carried on at the station by request, are for various reasons confined simply to a chemical examination regarding the presence or absence of foreign injurious matter due to infiltration from objectionable sources (sewage, etc.). The recognition of the presence and absence of objectionable bacterial growth is left to experts in that direction.

IV. Compilation of Analyses made at Amherst, Mass., of Agricultural Chemicals and Refuse Materials used for Fertilizing Purposes.

Prepared by C. S. Crocker.

[As the basis of valuation changes from year to year, no valuation is stated.]

1868-1895.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1894, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years. C. A. G.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	70	1.91	-	-	-	-	58.98	45.94	51.06	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash,	24	2.55	-	-	-	-	51.28	21.36	34.99	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash-magnesia,	19	4.77	-	-	-	-	29.48	16.96	24.06	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Carbonate of potash,	1	26.88	-	-	-	-	-	-	18.48	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Phosphate of potash,	1	3.76	-	-	-	-	-	-	32.56	-	-	37.50	-	-	-	-	-	-	-	13.43	-	-	.92
Kainite,	4	3.20	-	-	-	-	16.48	12.51	13.54	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.13
Carnallite,	1	-	-	-	-	-	-	-	13.68	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite,	1	4.82	-	-	-	-	-	-	8.42	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash,	4	1.30	-	14.58	11.60	12.71	45.62	44.76	45.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda,	25	1.47	-	16.01	14.28	14.70	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia,	26	1.05	-	21.68	19.59	22.16	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Phosphate of ammonia,	1	6.05	-	-	-	10.37	-	-	-	-	-	43.86	-	-	-	-	-	-	-	12.46	-	-	.82
Sulphate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste,	12	2.54	-	3.30	.52	2.22	30.94	1.55	13.66	-	-	-	-	-	-	37.04	.75	.19	-	1.85	-	46.25	-

Nitre salt-cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92
Wood ashes,	392	10.80	-	-	-	-	10.80	1.20	5.34	5.58	.05	1.55	-	-	-	-	33.46	3.31	.96	-	-	-	14.12
Cotton-seed-hull ashes,	44	8.25	-	-	-	-	42.12	9.91	22.54	13.67	2.89	8.35	-	-	-	-	9.33	10.47	1.71	-	-	-	13.32
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill,	11	5.93	-	-	-	-	8.83	1.25	3.98	32.36	16.61	16.07	-	-	-	-	33.58	1.87	4.65	-	-	-	17.74
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypsum,	3	13.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.86	-	-	48.01	-	-	.59
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster,	10	6.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.85	.75	-	45.75	-	-	2.50
Onondaga plaster,	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	96.10	-	-	-	-	-	1.33
Waste lime,	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime-kiln ashes,	14	15.46	-	-	-	-	2.12	.02	1.15	3.16	.36	1.23	-	-	-	-	41.99	2.60	-	-	17.75	-	7.87

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.																							
Marls (Massachusetts),	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia),	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia),	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia),	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl,	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina),	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called),	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano,	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida,	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida,	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15
Cuban guano,	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla),	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27

Mona Island guano,	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45
South Carolina rock phosphate,	6	1.45	-	-	-	-	-	-	-	30.51	24.70	27.47	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	29	2.09	-	-	-	-	-	-	-	38.97	6.95	26.15	-	-	-	-	30.40	-	7.56	-	-	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	3	3.35	-	-	-	-	.52	.32	.42	19.45	18.40	18.75	-	-	-	-	52.85	-	-	-	2.51	-	5.90
Dissolved bone-black,	4	11.14	47.50	-	-	-	-	-	-	17.54	15.35	16.04	14.56	1.12	.36	-	-	-	-	-	-	-	3.46
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	16	12.23	6.37	13.55	8.10	10.51	-	-	-	6.23	1.53	2.05	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances—Continued.																							
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	9	12.90	24.10	10.20	.96	4.88	3.50	.06	1.46	.67	.05	.35	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	156	7.00	53.03	4.70	1.57	3.96	-	-	-	32.52	15.16	22.29	.38	8.24	13.62	-	-	-	-	-	-	-	1.09

Meat and bone,	1	5.70	-	-	-	4.01	-	-	-	-	-	21.88	.26	8.32	13.30	-	-	-	-	-	-	-	-
Tankage,	6	9.84	-	9.16	6.94	8.14	-	-	-	12.60	4.03	10.20	-	-	-	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	67	12.45	21.50	11.40	5.97	7.45	-	-	-	15.91	5.50	8.46	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water,	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton seed meal,	28	6.53	5.78	7.70	4.02	6.67	2.38	.48	1.71	3.36	.73	1.59	-	-	-	-	-	-	-	-	-	-	.33
Rotten brewers' grain,	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	6	10.61	14.07	2.91	.90	2.29	8.82	3.76	6.44	2.09	.41	.60	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	1	6.44	60.60	9.33	.96	3.45	1.62	.66	1.20	1.80	.26	.73	-	-	-	-	-	-	-	-	-	-	45.00
Refuse from calico works,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust,	1	34.46	50.93	-	-	.50	-	-	.19	-	-	.21	-	-	-	-	.90	.90	-	-	-	-	47.46
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Concluded.																							
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel-grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-		1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60

Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	–	–	–	–	–	–	.94	.91	.37	4.13	–	–	–	34.88
Fresh-water mud,	1	40.37	–	–	–	1.37	–	–	.22	–	–	.26	–	–	–	–	1.27	.29	1.80	–	–	–	18.26
Muck,	21	62.19	13.75	2.54	.26	.86	–	–	–	.17	.08	.13	–	–	–	–	–	–	–	–	–	–	11.35
Peat,	10	61.50	8.20	1.40	.41	.85	–	–	.18	–	–	.08	–	–	–	–	.52	.72	2.14	–	–	–	2.20
Peat,	1	10.73	17.26	–	–	1.78	–	–	.06	–	–	.03	–	–	–	–	–	–	–	–	–	–	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Soot,	6	1.87	77.10	1.05	.09	.41	1.83	.21	.64	2.10	.19	1.06	–	–	–	–	3.11	–	7.19	–	–	–	67.25
Boiler soot,	1	18.80	–	–	–	–	–	–	.26	–	–	.70	–	–	–	–	58.28	1.46	1.46	–	32.95	–	3.09
IV. Animal Excrement, etc.																							
Barn-yard manure,	64	66.62	–	1.36	.21	.54	1.40	.13	.54	.75	.10	.40	–	–	–	–	.30	.19	–	–	–	–	8.48
Horse manure,	1	11.24	–	–	–	.74	–	–	2.82	–	–	1.46	–	–	–	–	–	–	–	–	–	–	12.60
Sheep manure,	1	64.88	–	–	–	.686	–	–	.525	–	–	.425	–	–	–	–	–	–	–	–	–	–	.404
Drainage from a manure heap,	1	93.20	3.66	–	–	.98	–	–	.88	–	–	.24	–	–	–	–	–	–	–	–	–	–	–
Poudrette, dry,	1	5.25	35.45	–	–	3.58	–	–	.49	–	–	5.74	–	–	–	–	–	–	–	–	–	–	4.65
Goose manure,	1	48.92	–	–	–	.21	–	–	.81	–	–	.95	–	–	–	–	–	–	–	–	–	–	–
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	–	–	–	–	1.19	.89	–	1.24	–	–	23.50
Hen manure, dry,	1	8.35	–	–	–	2.13	–	–	9.94	–	–	2.02	–	–	–	–	2.22	.62	–	–	–	–	34.64
Hen-house refuse,	1	3.43	–	–	–	.98	–	–	.60	–	–	1.28	–	–	–	–	–	–	–	–	–	–	–

V. Compilation of Analyses of Fodder Articles, Fruits, Sugar-producing Plants, Dairy Products, etc.,

MADE AT

AMHERST, MASS.

1868-1895.

Prepared by C. S. Crocker.

A. Analyses of Fodder Articles.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

C. Analyses of Fruit.

D. Analyses of Sugar-producing Plants.

E. Dairy Products.

F. Insecticides.

A. Analyses of Fodder Articles.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
I. Green Fodders.																	
Fodder corn,	31	31.47	10.33	20.29	17.19	6.05	9.86	6.10	1.42	2.44	63.13	42.02	56.51	31.53	18.27	25.29	5.90
Fodder corn ensilage,	38	37.43	13.12	21.70	16.72	5.98	8.66	6.49	1.82	3.80	65.69	42.99	54.28	38.92	17.67	27.73	5.33
Corn and soja-bean ensilage,	3	28.97	19.67	23.55	15.27	7.91	10.53	5.35	3.02	4.04	52.24	40.50	43.47	37.84	26.62	31.15	10.81
Oat and pea ensilage,	1	-	-	61.98	-	-	13.72	-	-	3.94	-	-	41.81	-	-	31.34	9.19
Millet and bean ensilage,	1	-	-	24.18	-	-	10.64	-	-	5.40	-	-	42.44	-	-	31.23	10.29
Ensilage of millet and white soja bean,	1	-	-	22.59	-	-	11.25	-	-	3.71	-	-	42.99	-	-	33.14	8.91
Ensilage of *Panicum miliaceum*,	1	-	-	21.99	-	-	7.46	-	-	3.34	-	-	49.08	-	-	31.80	8.32
Ensilage of *Panicum crus-galli*,	1	-	-	23.25	-	-	7.89	-	-	2.74	-	-	43.87	-	-	36.93	8.57
Sorghum,	6	23.18	12.38	17.41	11.84	7.46	8.74	2.00	1.21	1.55	64.93	47.65	56.15	29.27	22.00	26.73	6.83
Common millet,	9	42.29	21.32	35.42	12.16	5.43	7.50	3.99	2.09	2.74	58.61	46.39	53.93	33.98	24.88	30.99	4.84
Japanese millet (white head),	3	26.24	20.95	24.76	10.98	7.26	8.72	2.64	1.94	2.33	50.87	46.71	49.60	38.90	30.12	34.47	4.88
Japanese millet (red head),	6	33.83	22.66	27.33	7.99	4.92	6.90	2.45	1.58	2.01	60.83	50.11	52.91	35.29	25.21	32.10	6.08
Panicum miliaceum,	1	-	-	30.63	-	-	5.96	-	-	3.84	-	-	58.82	-	-	26.85	5.53
Panicum crus-galli,	2	29.28	24.89	27.08	11.45	7.98	9.71	2.79	2.20	2.49	57.88	46.50	52.20	29.51	26.31	27.91	7.69
White kibi,	2	24.26	22.85	23.56	15.14	10.79	12.97	1.61	1.50	1.56	53.66	52.30	47.29	35.29	25.21	32.10	6.08
Mochi millet,	3	42.29	30.07	37.42	11.90	6.11	9.94	1.94	1.74	1.81	67.08	49.06	55.69	29.80	20.01	25.56	7.00
Green oats,	6	55.69	15.51	25.97	20.47	7.05	13.91	3.95	2.02	2.89	50.69	40.42	44.91	33.12	25.20	30.04	8.25

Green rye,	2	37.89	98.05	**27.97**	9.64	5.38	**7.51**	2.46	1.86	**2.16**	65.37	40.20	**52.79**	42.17	21.52	**31.84**	5.70
Green barley,	1	-	-	**20.89**	-	-	**13.16**	-	-	**2.91**	-	-	**37.48**	-	-	**37.72**	8.73
Timothy (*Phleum pratense*),	2	35.00	34.26	**34.63**	8.83	8.20	**8.52**	2.07	1.95	**2.01**	51.33	51.23	**51.27**	33.23	32.50	**32.87**	5.33
Hungarian grass (*Setaria Italica* Beauv.),	2	25.93	25.69	**25.81**	9.39	9.38	**9.38**	2.43	1.01	**1.72**	57.80	48.01	**52.92**	31.23	24.66	**27.94**	8.04
Vetch and oats (one part vetch and four parts oats),	1	-	-	**20.84**	-	-	**13.27**	-	-	**3.90**	-	-	**43.69**	-	-	**30.34**	8.80
Vetch and oats (one part vetch and nine parts oats),	3	24.04	13.89	**18.97**	10.76	8.83	**10.06**	2.74	2.29	**2.53**	49.85	40.10	**44.75**	35.81	30.77	**33.59**	9.07
Vetch and oats (equal parts of each),	1	-	-	**17.98**	-	-	**16.77**	-	-	**2.79**	-	-	**41.33**	-	-	**29.80**	9.31
Barley and peas,	1	-	-	**16.09**	-	-	**13.40**	-	-	**3.00**	-	-	**41.79**	-	-	**33.49**	8.32
Oats and peas,	2	18.41	13.68	**16.04**	16.01	14.17	**15.09**	3.40	2.29	**2.84**	48.14	40.56	**44.36**	32.20	26.66	**29.43**	8.28
Horse bean (*Vicia faba* L.),	1	-	-	**15.17**	-	-	**16.68**	-	-	**2.31**	-	-	**47.09**	-	-	**28.17**	5.75
Flat pea (*Lathyrus sylvestris*),	2	21.38	21.20	**21.29**	30.65	27.26	**28.95**	5.00	3.29	**4.14**	35.06	31.83	**33.46**	28.27	20.38	**24.32**	9.13
Soja bean (*Soja hispida*),	14	36.36	18.54	**24.48**	22.19	13.71	**17.26**	8.98	2.71	**4.57**	47.89	34.24	**41.73**	31.89	21.67	**26.47**	9.97
Soja bean (early white),	4	34.02	20.49	**28.24**	20.13	13.81	**16.48**	2.97	2.16	**2.71**	49.94	37.23	**45.27**	27.12	17.28	**22.76**	12.78
Soja bean (early green),	1	-	-	**30.16**	-	-	**19.35**	-	-	**3.87**	-	-	**40.30**	-	-	**23.51**	12.97
Soja bean (early black),	1	-	-	**17.79**	-	-	**16.18**	-	-	**3.38**	-	-	**42.52**	-	-	**25.06**	12.86
Soja bean (medium black),	1	-	-	**23.13**	-	-	**21.67**	-	-	**6.76**	-	-	**37.18**	-	-	**21.73**	12.66
Soja bean (late),	4	31.89	20.22	**26.02**	27.49	18.56	**22.84**	3.34	2.25	**2.76**	44.84	37.97	**39.70**	23.62	16.47	**21.09**	13.61
Bokhara clover (*Melilotus alba* Desr.),	3	24.14	19.01	**21.22**	23.37	17.18	**19.72**	3.51	2.76	**3.04**	38.43	37.02	**37.89**	33.99	24.43	**29.46**	9.89
Kidney vetch (*Anthyllis vulneraria*),	1	-	-	**19.15**	-	-	**18.43**	-	-	**3.51**	-	-	**49.84**	-	-	**14.94**	13.28
Serradella (*Ornithopus sativus* Brot.),	3	19.42	15.40	**17.59**	17.75	12.17	**15.01**	2.65	2.09	**2.41**	46.41	35.45	**41.51**	38.76	26.21	**30.08**	10.99
Prickly comfrey (*Symphytum officinale*),	1	-	-	**13.21**	-	-	**17.49**	-	-	**2.06**	-	-	**48.30**	-	-	**11.03**	21.12
White lupine (*Lupinus albus*),	1	-	-	**14.65**	-	-	**18.71**	-	-	**2.41**	-	-	**42.67**	-	-	**31.18**	5.03

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
I. Green Fodders — Concluded.																	
Yellow lupine (*Lupinus lutens*),	1	–	–	13.95	–	–	17.84	–	–	1.87	–	–	42.05	–	–	27.10	11.14
Spanish moss (*Tillandsia usneoides*),	1	–	–	39.20	–	–	4.45	–	–	2.54	–	–	57.73	–	–	32.61	2.67
II. Hay and Dry Coarse Fodders.																	
English hay (mixed hay),	56	91.94	66.59	85.53	14.19	6.19	9.46	4.10	1.56	2.85	54.72	43.63	50.29	35.55	26.41	31.05	6.35
Rowen of mixed hays,	15	91.76	75.55	82.74	14.70	11.63	12.72	5.03	2.60	3.62	53.52	41.92	49.68	31.50	24.25	26.77	7.21
Timothy hay,	6	92.76	81.26	89.39	9.37	7.24	8.66	2.65	1.95	2.22	54.43	50.01	51.34	36.59	29.21	32.90	4.88
Red-top hay (*Agrostis vulgaris* With.)	4	93.19	91.76	92.30	8.40	6.41	7.88	1.69	1.50	1.60	54.74	50.32	52.63	34.11	31.12	32.92	4.97
Kentucky blue-grass (*Poa pratensis* L.),	2	96.10	93.22	94.66	8.78	8.65	8.72	2.08	2.03	2.06	49.61	44.11	46.29	36.84	32.21	34.58	8.35
Orchard grass (*Dactylis glomerata* L.),	4	91.62	90.86	91.17	11.29	7.57	9.43	3.56	2.40	2.91	47.34	43.50	46.16	35.79	34.12	34.89	7.05
Meadow fescue (*Festuca pratensis* Huds.),	5	94.70	87.84	91.09	7.85	5.89	6.76	2.17	1.65	1.87	49.18	42.03	46.31	39.90	34.61	36.93	8.73
Perennial rye-grass (*Lolium perenne* L.),	4	93.64	90.50	92.60	16.56	6.59	11.71	3.15	1.59	2.37	55.77	38.82	48.14	30.86	26.79	29.64	8.14
Italian rye-grass (*Lolium Italicum* A. Br.),	4	92.62	90.70	91.54	9.75	6.20	8.15	2.07	1.39	1.85	52.80	43.09	49.14	36.90	31.27	33.34	7.52
Hungarian grass,	1	–	–	92.55	–	–	9.45	–	–	2.22	–	–	50.64	–	–	31.96	5.73
Barn-yard grass (*Panicum crus-galli* L.),	1	–	–	93.35	–	–	15.27	–	–	1.95	–	–	30.24	–	–	33.72	10.02
Hay of black grass,	1	–	–	91.25	–	–	6.72	–	–	3.37	–	–	49.47	–	–	31.41	9.03
Low meadow hay,	1	–	–	91.99	–	–	9.51	–	–	1.88	–	–	46.27	–	–	35.59	6.75
Salt hay,	2	91.92	90.34	91.13	4.35	3.77	4.06	3.24	2.65	2.95	60.15	60.14	60.14	27.84	27.82	27.83	5.02

Millet,	6	93.85	90.25	92.54	8.88	7.09	7.81	3.63	.89	2.05	55.80	49.62	51.74	35.91	29.80	33.32	5.08
Oats in bloom,	1	–	–	93.57	–	–	6.58	–	–	2.92	–	–	50.03	–	–	34.06	6.41
Oats in milk,	1	–	–	90.45	–	–	10.89	–	–	2.69	–	–	46.02	–	–	34.32	6.08
Oats, ripe,	1	–	–	91.30	–	–	6.05	–	–	2.61	–	–	48.92	–	–	36.31	6.11
Winter rye in bloom,	1	–	–	91.45	–	–	10.66	–	–	2.57	–	–	47.40	–	–	32.97	6.40
Barley in milk,	1	–	–	89.75	–	–	10.26	–	–	2.76	–	–	52.91	–	–	29.12	4.95
Common buckwheat,	1	–	–	91.50	–	–	17.90	–	–	3.04	–	–	45.08	–	–	19.35	14.63
Silver-hull buckwheat,	1	–	–	91.09	–	–	12.22	–	–	2.55	–	–	47.99	–	–	27.07	10.17
Japanese buckwheat,	1	–	–	94.29	–	–	10.80	–	–	2.22	–	–	38.60	–	–	36.02	12.36
Dry fodder corn,	4	93.35	90.58	92.11	9.31	6.17	7.74	2.76	1.11	1.84	58.89	53.86	55.97	33.75	23.03	29.31	5.14
Corn stover,	28	94.44	75.00	88.33	12.15	5.46	7.37	2.63	1.08	1.38	63.05	44.65	50.52	38.83	20.93	34.90	5.83
Teosinte (*Euchlæna luxurians* Dur. and Asch.),	1	–	–	93.94	–	–	9.71	–	–	1.28	–	–	53.18	–	–	28.88	6.95
Mammoth red clover (*Trifolium medium* L.),	3	92.66	82.47	88.59	18.50	14.06	15.75	2.25	1.86	2.13	48.98	46.51	44.77	33.72	20.16	27.51	9.84
Alsike clover (*Trifolium hybridum* L.),	6	93.92	86.48	90.07	17.55	14.77	16.63	3.26	1.88	2.58	46.64	38.03	42.72	32.34	21.44	26.17	11.90
Medium red clover (*Trifolium pratense* L.),	2	94.90	93.98	94.44	15.01	14.63	14.82	2.62	2.36	2.49	43.88	42.81	43.34	30.76	29.97	30.37	8.98
Lucerne (alfalfa) (*Medicago sativa* Desr.),	5	95.40	84.00	91.40	16.34	11.12	14.22	2.50	1.04	1.65	51.62	40.25	46.20	34.39	25.42	29.72	8.11
Sand lucerne (*Medicago media* Pers.),	1	–	–	91.20	–	–	16.26	–	–	2.59	–	–	50.31	–	–	21.27	9.57
Bokhara clover (*Melilotus alba* Desr.),	5	93.64	91.50	92.09	23.37	11.81	17.18	4.79	1.85	3.15	51.36	37.02	40.79	33.05	28.08	29.90	8.93
Blue melilot (*Melilotus cœrulea* Desr.),	1	–	–	91.78	–	–	13.81	–	–	1.67	–	–	42.48	–	–	27.17	14.87
Sainfoin (*Onobrychis sativa*),	3	91.28	87.83	90.11	18.11	15.95	17.25	4.49	2.78	3.36	50.55	42.32	46.66	26.95	22.49	24.02	8.71
Sulla (*Hedysarum coronarium*),	2	91.68	89.59	90.61	17.03	16.90	16.97	3.16	2.39	2.78	58.66	41.89	50.26	28.95	12.38	20.67	9.32
Hairy lotus (*Lotus villosus* Thuill.),	2	89.32	87.64	88.48	16.12	13.49	14.81	3.00	2.69	2.85	57.82	50.80	54.29	24.48	15.07	19.78	8.27
Summer rape (*Brassica napus*),	1	–	–	88.87	–	–	14.43	–	–	3.79	–	–	45.38	–	–	18.15	18.25

A. *Analyses of Fodder Articles* — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —													
					PROTEIN.			FAT.			NITROGEN-FREE EXTRACT.			FIBRE.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
II. Hay and Dry Coarse Fodders — Concluded.																	
Winter rape (*Brassica napus*),	1	-	-	89.85	-	-	15.16	-	-	3.06	-	-	47.08	-	-	12.26	22.44
Dwarf Essex rape (*Brassica napus*),	1	-	-	92.29	-	-	12.86	-	-	3.80	-	-	42.27	-	-	18.96	16.11
Soja bean,	4	93.88	79.91	87.78	19.06	14.89	16.23	8.33	2.55	4.72	51.28	41.09	46.70	27.73	20.76	24.02	8.33
Cow-pea,	3	90.70	90.25	90.43	17.17	16.95	17.05	4.49	3.81	4.06	51.41	46.06	47.93	23.58	19.06	21.67	9.29
Small pea (*Lathyrus sativus*),	1	-	-	94.20	-	-	16.57	-	-	1.49	-	-	42.76	-	-	32.88	6.30
Flat pea (*Lathyrus sylvestris*),	1	-	-	91.10	-	-	24.04	-	-	1.78	-	-	33.03	-	-	31.76	9.39
Serradella,	3	92.80	87.23	90.44	17.97	15.26	17.03	2.91	2.37	2.55	50.22	44.49	48.18	25.92	24.37	25.15	7.09
Hairy vetch (*Vicia villosa* Roth.),	1	-	-	92.56	-	-	19.58	-	-	1.22	-	-	38.95	-	-	31.68	8.37
Common vetch (*Vicia sativa* L.),	2	91.65	90.55	91.10	15.76	14.42	15.09	2.69	2.30	2.50	44.34	43.29	43.80	30.68	30.05	30.37	8.24
Scotch tares,	1	-	-	84.20	-	-	22.00	-	-	1.89	-	-	31.46	-	-	30.89	13.76
Vetch and oats,	3	94.22	83.33	88.35	13.51	7.70	9.64	3.45	2.53	3.11	49.95	41.51	46.83	36.22	30.15	32.70	7.72
Vetch and oats (equal parts of each),	2	90.65	90.64	90.64	18.88	15.16	17.02	3.13	2.63	2.88	42.24	38.57	40.41	31.28	29.83	30.55	9.14
Vetch and barley,	2	91.51	90.76	91.13	14.44	13.36	13.90	2.56	2.12	2.34	46.55	43.70	45.13	32.58	32.25	32.41	6.22
Vetch, oats and horse bean,	1	-	-	89.81	-	-	18.93	-	-	2.70	-	-	37.94	-	-	30.07	10.36
Horse-bean straw,	1	-	-	90.85	-	-	9.69	-	-	1.51	-	-	37.77	-	-	41.44	9.59
Soja-bean straw,	3	92.37	86.03	88.57	5.73	5.34	5.48	3.49	1.17	2.15	43.72	41.02	42.81	46.51	36.80	42.38	7.18
White daisy (*Chrysanthemum leucanthemum* L.),	1	-	-	90.35	-	-	7.68	-	-	2.32	-	-	46.86	-	-	36.09	7.05

Dry carrot tops,	1	-	-	90.24	-	-	20.12	-	-	2.01	-	-	50.39	-	-	13.61	13.87
Wheat straw,	1	-	-	93.80	-	-	7.20	-	-	1.63	-	-	50.46	-	-	35.91	4.80
Barley straw,	2	91.41	88.56	89.98	9.24	6.21	7.72	3.38	2.49	2.93	48.23	46.52	46.89	39.84	33.85	36.84	5.62
Japanese millet (white head),	1	-	-	91.48	-	-	7.67	-	-	2.41	-	-	49.87	-	-	34.99	5.06
Japanese millet (red head),	1	-	-	91.13	-	-	5.76	-	-	1.70	-	-	49.66	-	-	39.52	3.36
Millet straw,	1	-	-	86.55	-	-	4.95	-	-	1.43	-	-	44.96	-	-	41.82	6.84
Straw (*Panicum crus-galli*),	1	-	-	87.35	-	-	6.10	-	-	2.44	-	-	50.20	-	-	35.90	5.36
Straw (*P. miliaceum*),	1	-	-	87.83	-	-	3.94	-	-	3.01	-	-	44.72	-	-	42.16	6.17
Straw (*P. Italicum*),	1	-	-	80.28	-	-	4.17	-	-	1.59	-	-	46.39	-	-	41.54	6.31
III. Roots, Bulbs, Tubers, etc.																	
Beets, red,	7	14.51	9.75	12.17	15.40	7.82	12.29	1.76	.59	.94	79.33	66.87	72.19	7.56	4.29	6.00	8.58
Beets, sugar,	12	19.53	9.87	14.60	17.44	7.32	11.18	.83	.58	.67	81.50	61.93	75.62	9.69	4.82	6.55	5.98
Beets, yellow fodder,	4	15.01	9.40	11.46	13.96	9.29	11.69	2.02	.84	1.39	75.22	61.90	69.33	9.66	7.26	8.14	9.45
Mangolds,	4	13.08	11.49	12.06	12.84	7.04	9.54	1.14	.73	.97	73.38	70.32	71.03	9.98	7.08	8.45	10.01
Ruta-bagas,	3	12.77	8.25	10.88	11.46	10.34	11.01	2.32	1.23	1.53	68.58	62.27	65.88	13.12	11.03	11.83	9.75
Turnips,	5	12.80	8.22	10.38	11.39	9.67	10.57	2.23	1.42	1.79	70.62	65.91	67.51	13.34	10.12	11.68	8.45
Carrots,	5	12.52	9.95	10.98	9.75	7.29	8.76	3.94	1.41	2.09	73.96	67.24	71.63	10.76	7.55	9.08	8.44
Parsnips,	1	-	-	19.66	-	-	6.88	-	-	3.37	-	-	74.65	-	-	7.67	7.43
Potatoes,	13	21.95	13.91	19.01	13.56	6.24	10.05	.83	.17	.49	87.56	78.80	*81.69	3.55	1.91	2.64	5.13
Artichokes,	1	-	-	22.51	-	-	12.82	-	-	.95	-	-	77.26	-	-	4.18	4.79
Japanese radish (*merinia*),	1	-	-	6.74	-	-	7.47	-	-	1.05	-	-	70.89	-	-	10.27	10.32
Japanese radish (*niyas hige*),	1	-	-	7.42	-	-	6.51	-	-	.96	-	-	72.87	-	-	9.79	9.87

* Starch (six determinations), 69.95 per cent.

A. Analyses of Fodder Articles — Continued.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain —													
					Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
IV. Grains, Seeds, Fruits, etc.																	
Corn kernels,	29	91.98	65.50	89.43	15.02	8.49	12.18	9.43	4.25	5.42	83.98	71.06	78.49	3.38	1.03	2.12	1.69
Sweet corn kernels,	1	–	–	88.02	–	–	12.57	–	–	9.56	–	–	73.83	–	–	2.41	1.63
Wheat kernels,	1	–	–	89.42	–	–	13.35	–	–	1.79	–	–	80.26	–	–	2.42	2.18
Oat kernels,	1	–	–	86.84	–	–	14.44	–	–	6.83	–	–	66.21	–	–	9.03	3.49
Broom-corn seed,	1	–	–	85.90	–	–	11.21	–	–	4.05	–	–	74.05	–	–	8.34	2.35
Soja beans,	3	94.15	80.73	85.83	35.98	32.58	33.97	21.89	18.42	20.19	34.88	32.87	33.98	7.57	5.15	6.02	5.84
Horse beans,	1	–	–	89.72	–	–	30.03	–	–	1.11	–	–	56.48	–	–	8.11	4.27
Red adzinki beans,	2	85.18	83.10	84.14	25.14	23.75	24.45	.88	.76	.82	66.48	65.41	65.95	4.68	4.50	4.59	4.19
Saddle beans,	1	–	–	87.62	–	–	15.12	–	–	16.58	–	–	57.34	–	–	4.75	6.21
Daidzu beans,	1	–	–	88.47	–	–	38.99	–	–	18.59	–	–	30.41	–	–	4.97	7.04
Millet seed,	3	87.32	86.11	86.65	14.60	11.76	13.24	4.94	3.53	4.32	73.19	66.94	70.56	10.23	6.48	8.88	3.00
Chestnuts,	1	–	–	55.14	–	–	13.32	–	–	14.46	–	–	67.05	–	–	2.45	2.72
Cranberries,	1	–	–	10.59	–	–	4.40	–	–	5.61	–	–	76.37	–	–	11.63	1.99
Apples,	2	24.83	19.68	22.26	4.57	3.92	4.25	2.81	1.71	2.26	86.21	83.44	84.81	7.05	6.14	6.60	2.08
V. Flour and Meal.																	
Corn meal,	36	89.95	79.81	86.24	16.08	9.73	11.04	5.14	3.10	3.86	83.61	73.20	81.38	3.60	1.20	2.15	1.57
Corn and cob meal,	37	94.00	80.89	89.47	15.06	7.82	10.01	5.27	3.36	4.19	81.41	70.13	76.62	10.41	5.63	7.54	1.64

Cooked feed (oats and corn),	1	-	-	94.45	-	-	14.75	-	-	5.34	-	-	67.14	-	-	8.73	4.04
Hominy meal,	4	-	-	90.00	4.15	3.00	3.57	.67	.38	.57	63.62	60.58	61.72	33.77	31.36	32.93	1.21
Ground oats,	2	91.11	90.29	90.70	13.20	11.93	12.56	4.52	3.51	4.01	-	-	70.21	-	-	9.29	3.93
Ground barley,	5	89.09	82.59	86.91	14.93	9.99	12.95	2.57	1.69	2.18	78.25	74.47	76.63	8.03	4.10	6.47	2.77
Broom-corn meal,	1	-	-	86.46	-	-	11.14	-	-	4.13	-	-	74.30	-	-	8.00	2.43
Pea meal,	1	-	-	91.15	-	-	20.95	-	-	1.67	-	-	55.02	-	-	19.42	2.94
Peanut meal,	1	-	-	92.00	-	-	53.26	-	-	11.69	-	-	27.00	-	-	3.76	4.29
Bean meal,	1	-	-	88.02	-	-	12.57	-	-	9.56	-	-	73.83	-	-	2.41	1.63
Soja-bean meal,	1	-	-	89.20	-	-	41.18	-	-	18.17	-	-	30.60	-	-	5.01	5.04
Millet meal (*Panicum Italicum*),	1	-	-	89.38	-	-	35.12	-	-	17.35	-	-	38.95	-	-	3.86	4.72
VI. By-products and Refuse.																	
Linseed cake, old process,	8	92.52	88.50	90.32	39.97	83.98	36.65	9.87	6.24	7.30	44.72	37.76	40.51	9.69	8.04	8.62	6.92
Linseed cake, new process,	7	94.94	88.17	91.65	41.02	35.03	39.38	4.08	2.17	3.24	46.49	40.54	41.74	10.31	8.59	9.28	6.36
Cotton-seed meal,	32	94.42	88.81	92.11	51.79	36.54	45.24	14.72	8.41	11.68	35.84	20.22	28.11	10.83	5.08	7.44	7.51
Cotton-seed bran,	1	-	-	88.90	-	-	11.82	-	-	3.17	-	-	50.34	-	-	31.09	3.58
Wheat bran,	43	92.58	86.30	89.35	20.54	15.67	17.86	6.36	2.80	5.00	62.83	51.77	58.34	14.26	7.49	10.98	7.82
Spring-wheat bran,	3	91.03	87.26	88.67	19.54	16.19	17.78	5.46	5.37	5.41	59.39	56.54	57.50	13.75	10.84	12.02	7.29
Winter-wheat bran,	2	87.76	86.94	87.35	17.04	16.24	16.64	4.57	3.43	4.00	62.83	59.83	61.33	12.74	9.32	11.03	7.00
Wheat middlings,	7	90.75	87.57	89.76	20.07	15.13	17.19	6.46	3.19	5.40	74.30	58.03	62.46	11.21	1.40	8.46	6.49
Rye bran,	2	91.82	86.30	89.06	18.98	16.52	17.75	3.03	2.07	2.55	73.56	69.24	71.70	4.54	3.46	4.00	4.30
Rye middlings,	1	-	-	87.46	-	-	13.15	-	-	5.61	-	-	73.52	-	-	3.70	4.02
Pea bran,	1	-	-	92.86	-	-	10.31	-	-	1.16	-	-	39.04	-	-	46.16	3.33
Buckwheat middlings,	1	-	-	88.49	-	-	25.49	-	-	7.53	-	-	66.36	-	-	5.18	5.44

A. *Analyses of Fodder Articles* — Concluded.

NAME.	Analyses.	Dry Matter.			One Hundred Parts of Dry Matter contain — Protein.			Fat.			Nitrogen-free Extract.			Fibre.			Ash.
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	
VI. By-products and Refuse — Concluded.																	
Gluten meal,	38	93.67	68.32	90.98	39.28	25.75	29.99	14.47	3.92	9.13	66.26	48.26	56.34	10.06	.41	3.59	.95
Gluten meal (Chicago),	3	92.71	88.89	90.76	37.09	30.19	33.53	9.22	4.60	6.80	57.97	56.64	57.55	1.73	.73	1.23	.89
Gluten meal (King),	2	93.35	92.22	92.78	38.57	36.19	37.38	21.44	19.68	20.56	38.84	38.56	38.74	1.62	1.41	1.51	1.84
Gluten feed (Buffalo),	15	93.67	90.61	91.93	31.05	21.11	25.01	14.76	9.18	12.90	62.79	48.80	53.64	10.06	5.43	7.42	1.03
Gluten feed (Pope),	1	-	-	86.02	-	-	33.68	-	-	16.34	-	-	42.43	-	-	1.80	.75
Gluten feed (Peoria),	2	92.93	92.50	92.71	22.71	21.35	22.03	14.33	13.62	13.97	55.27	53.50	54.39	8.86	8.30	8.58	1.03
Maize feed (Chicago),	4	91.40	90.25	91.41	29.40	21.33	25.87	7.90	6.15	7.06	62.12	53.85	57.53	9.65	7.93	8.70	.84
Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Dry distillery feed (Atlas mills),	1	-	-	88.75	-	-	37.30	-	-	15.28	-	-	35.07	-	-	11.94	.41
Glucose feed (Richardson),	1	-	-	93.68	-	-	23.12	-	-	11.67	-	-	52.41	-	-	11.67	1.13
Corn-germ meal,	1	-	-	90.65	-	-	28.26	-	-	11.82	-	-	42.49	-	-	9.18	8.25
Corn-germ feed,	1	-	-	92.43	-	-	10.81	-	-	12.17	-	-	62.10	-	-	14.05	.87
Corn screenings,	1	-	-	88.98	-	-	8.29	-	-	4.48	-	-	81.57	-	-	3.27	2.39
Proteina (mixed feed),	4	93.20	89.94	91.61	27.23	20.53	23.67	8.24	5.01	7.20	61.53	51.11	55.55	12.33	10.18	10.92	2.66
Excelsior feed,	1	-	-	92.92	-	-	6.75	-	-	5.42	-	-	65.75	-	-	14.65	4.43
Corn screenings,	1	-	-	88.98	-	-	8.29	-	-	4.48	-	-	81.57	-	-	3.27	2.39
Oat feed,	4	90.66	90.53	92.20	15.60	11.02	13.15	8.23	3.95	5.32	68.08	57.28	63.88	17.73	8.06	11.52	6.13
Rye feed,	2	91.77	90.37	91.05	16.62	13.65	15.09	3.04	2.79	2.91	77.51	73.38	75.44	3.62	3.52	3.58	2.98

Starch feed (Pope),	1	-	-	94.52	-	-	11.28	-	-	11.30	-	-	61.31	-	-	15.21	.90
Cocoanut meal,	1	-	-	90.67	-	-	22.61	-	-	12.88	-	-	40.03	-	-	18.83	5.68
Louisiana rice bran,	1	-	-	89.75	-	-	9.82	-	-	9.66	-	-	55.07	-	-	14.86	10.59
Peanut feed,	2	90.92	89.08	89.99	10.31	9.54	9.92	7.61	4.49	6.05	19.55	17.35	18.46	62.82	62.48	62.65	2.92
Peanut husks,	1	-	-	87.02	-	-	5.74	-	-	1.90	-	-	15.09	-	-	75.91	1.36
Bakery refuse,	1	-	-	86.66	-	-	9.23	-	-	6.36	-	-	72.34	-	-	.43	11.64
Vinegar mash,	1	-	-	5.51	-	-	16.50	-	-	8.45	-	-	63.47	-	-	8.55	3.03
Refuse from starch works,	1	-	-	42.96	-	-	22.41	-	-	10.17	-	-	58.98	-	-	7.54	.90
Oat meal and barley refuse,	1	-	-	92.24	-	-	7.45	-	-	3.80	-	-	62.61	-	-	22.30	3.84
Glucose refuse,	1	-	-	93.29	-	-	21.06	-	-	10.55	-	-	62.42	-	-	4.77	1.20
Spent brewers' grain,	4	93.02	88.00	90.13	33.16	16.08	23.29	6.29	1.95	4.89	67.62	42.32	54.04	15.90	8.07	11.25	4.53
Malt sprouts,	1	-	-	84.63	-	-	27.17	-	-	3.85	-	-	47.92	-	-	14.75	6.31
Damaged wheat,	1	-	-	86.90	-	-	16.26	-	-	2.51	-	-	75.85	-	-	3.11	2.31
Cocoa dust from cocoa manufactory,	1	-	-	92.90	-	-	15.47	-	-	25.85	-	-	45.99	-	-	5.86	6.83
Broom-corn waste,	1	-	-	91.30	-	-	6.78	-	-	1.00	-	-	48.09	-	-	39.25	4.88
Refuse from cows' manger,	4	85.73	64.81	77.44	6.63	4.31	5.01	1.09	.74	.98	45.46	42.12	43.74	46.91	38.72	43.94	6.33
Refuse from cows' manger (ensilage),	6	39.89	21.73	27.07	11.56	8.64	8.38	2.04	1.30	1.48	44.96	41.67	45.97	40.37	33.98	34.57	9.60
Cotton hulls,	3	91.85	88.55	89.98	5.36	4.10	4.79	4.27	1.79	2.81	46.75	38.59	43.34	51.40	40.24	46.08	2.98
Apple pomace,	3	21.78	12.49	17.16	7.73	5.75	6.81	5.93	3.17	4.49	72.93	63.29	69.49	21.67	13.15	17.13	2.08
Apple pomace ensilage,	1	-	-	14.67	-	-	8.22	-	-	7.36	-	-	58.03	-	-	22.18	4.21
Sugar beet pulp, from diffusion battery,	1	-	-	10.32	-	-	12.41	-	-	.95	-	-	61.86	-	-	23.74	1.04
Corn cobs,	6	94.05	90.00	92.35	4.15	1.46	2.91	.77	.38	.56	63.62	58.78	61.21	37.84	31.36	33.96	1.36
Palmetto root,	1	-	-	88.49	-	-	3.82	-	-	.53	-	-	69.95	-	-	21.26	4.44

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients.

NAME.	Analyses.	*Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
I. Green Fodders.												
Fodder corn,	14	78.61	.407	4.84	.327	.018	.153	.091	.018	.148	.380	$1 93
Fodder corn ensilage,	7	80.19	.422	-	.385	.050	.100	.090	.020	.129	.255	-
Corn and soja bean ensilage,	1	71.03	.790	-	.444	-	-	-	-	.420	-	3 67
Ensilage of millet and white soja bean,	1	77.41	.400	-	.540	-	-	-	-	.130	-	-
Ensilage of *Panicum miliaceum*,	1	78.01	.260	-	.430	-	-	-	-	.110	.500	1 49
Ensilage of *Panicum crus-galli*,	1	76 75	.294	-	.621	-	-	-	-	.133	-	1 84
Sorghum,	7	82.19	.233	-	.229	.025	.076	.075	.012	.088	.136	1 16
White kibi,	2	76.45	.489	1.22	.200	.045	.232	.148	.019	.136	.652	2 07
Mochi millet,	3	62.58	.609	2.62	.407	.120	.201	.217	.021	.188	.708	2 76
Millet (*Panicum crus-galli*),	1	75.11	.455	-	.494	-	-	-	-	.109	-	2 24
Green oats,	3	83.36	.489	1 31	.381	.217	.154	.134	.018	.130	.496	2 26
Green rye,	2	72.03	.302	-	.636	-	-	-	-	.117	-	1 87
Vetch and oats,	1	86.11	.236	1.72	.789	.031	.087	.030	.012	.094	.331	1 78
Horse bean,	1	74.71	.675	-	.346	.028	.346	.157	.050	.083	.514	2 85
Soja bean,	1	73.20	.292	-	.531	-	-	-	-	.151	-	1 76
Soja bean (early white),	1	66.56	.943	-	.905	-	-	-	-	.214	-	4 51

Soja bean (early green),	1	69.84	.835	-	.707	-	-	-	-	.201	-	3 90
Soja bean (medium black),	1	76.87	.803	-	.566	-	-	-	-	.175	-	3 61
Soja bean (late),	1	79.78	.600	-	.677	-	-	-	-	.138	-	2 98
Kidney vetch,	1	80.85	.563	-	.346	.218	.907	.055	.027	.085	.155	2 46
Cow-pea vines,	1	78.81	.274	1.47	.306	.063	.300	.099	.016	.098	.077	1 39
Prickley comfrey,	1	86.79	.370	-	.759	.122	.309	.041	.058	.115	-	2 24
Serradella,	2	82.59	.411	1.82	.420	.097	.460	.067	.021	.140	.097	2 04
Common buckwheat,	1	84.65	.440	-	.538	-	-	-	-	.089	.577	2 22
Flat pea (*Lathyrus sylvestris*),	1	78.62	1.049	-	.449	-	.302	.088	.056	.140	.247	4 30
Hungarian grass,	1	74.31	.386	-	.549	-	-	-	-	.159	-	2 11
White lupine,	1	85.35	.440	-	.253	.100	.450	.107	.025	.051	.131	1 87
Yellow lupine,	1	85.05	.398	-	.441	.086	.288	.049	.008	.092	.161	1 49
Spanish moss,	1	60.80	.279	1.04	.255	.263	.089	.122	.029	.030	.191	1 30
II. Hay and Dry Coarse Fodders.												
English hay,	10	11.94	1.294	6.34	1.528	.110	.344	.240	.021	.286	.911	6 49
Rowen,	13	18.53	1.629	9.57	1.499	.140	.640	.280	.034	.442	1.840	-
Timothy hay,	3	11.26	1.240	4.93	1.460	.180	.620	.120	.006	.342	1.000	6 28
Red-top,	4	7.71	1.150	4.59	1.020	.438	.571	.134	.036	.360	1.736	5 51
Kentucky blue-grass,	2	5.34	1.320	-	1.694	.129	.398	-	.044	.431	2.863	6 91

* The valuation is based on the following prices per pound of the essential fertilizing ingredients: nitrogen, 17½ cents; potassium oxide, 5½ cents; phosphoric acid, 5 cents.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
II. Hay and Dry Coarse Fodders — Concluded.												
Orchard grass,	4	8.84	1.310	6.42	1.879	.225	.456	.297	.033	.414	2.060	$7 07
Meadow fescue,	6	8.89	.992	8.08	2.036	.301	.576	.187	.028	.339	1 537	6 18
Perennial rye-grass,	2	9.13	1.227	6.79	1.553	.307	.642	.337	.044	.559	2.262	6 56
Italian rye-grass,	4	8.71	1.189	-	1.273	.451	.857	.321	.071	.556	2.598	6 13
Salt hay,	1	5.36	1.180	-	.718	.017	.371	.335	.028	.248	-	4 46
Japanese millet (white head),	3	10.45	1.105	5.80	1.223	.012	.465	.377	.028	.403	1 033	5 62
Common buckwheat,	1	8.50	2.620	-	3.238	-	-	-	-	.532	3.436	13 04
Silver-hull buckwheat,	1	8.91	1.780	-	2.380	-	2.290	.526	.059	.660	.462	9 71
Japanese buckwheat,	1	5.72	1.629	-	3.320	.349	3.418	.421	.148	.852	.378	10 21
Fodder corn,	7	7.85	1.763	4.91	.889	.175	.605	.500	.075	.542	1.270	7 69
Corn stover,	17	9 33	1.038	3 74	1.375	.112	.622	.384	.068	.288	1.782	5 43
Teosinte,	1	6.06	1 460	6.53	3.696	.109	1.597	.458	.021	.546	.315	9 72
Summer rape,	1	11 13	2.053	-	4.670	.994	3 691	.522	.031	.572	.709	12 89
Millet hay,	1	9.75	1.280	-	1.690	.020	.500	.460	.030	.490	1.360	6 83
Mammoth red clover,	3	11.41	2 231	8.72	1.223	.389	3.141	.613	.111	.546	.779	9 98

Medium red clover,	2	7.91	2.184	8.36	2.286	.210	1.689	.402	.099	.447	.919	10 61
Alsike clover,	6	9.94	2.342	11.11	2.227	.309	2.153	.537	.197	.668	1.776	11 31
Lucerne (alfalfa),	4	6.26	2.075	6.82	1.461	.814	2.211	.406	.078	.526	.513	9 40
Bokhara clover,	2	7.43	1.975	7.70	1.832	.114	1.784	.347	.023	.558	.057	9 49
Blue melilot,	1	8.22	1.919	13.65	2.796	.270	1.449	.260	.349	.544	4.008	10 34
Sainfoin,	1	12.17	2.630	7.55	2.020	.540	1.160	.430	.010	.760	.470	12 19
Sulla,	2	9.39	2.460	-	2.093	.223	2.497	.350	.114	.453	.614	11 37
Lotus villosus,	2	11.52	2.095	8.23	1.807	.499	2.220	.476	.112	.594	.976	9 91
Soja bean,	2	6.30	2.320	6.47	1.079	.148	2.760	1.178	.115	.667	.977	9 97
Cow pea,	1	9.00	1.635	8.40	.913	.122	2.696	.688	.046	.527	.882	7 25
Small pea,	1	5.80	2.497	-	1.990	.469	1.373	.276	.138	.592	1.081	11 52
Flat pea (*Lathyrus sylvestris*),	1	8.90	3.514	-	2.340	-	1.631	.454	.179	.820	1.880	15 69
Serradella,	2	7.39	2.697	10.60	.652	.656	2.545	.461	.066	.777	.590	11 97
Scotch tares,	1	15.80	2.964	-	3.004	.238	1.698	.354	.460	.815	4.062	14 49
Spring vetch,	1	8.21	2.204	-	2.760	-	1.710	-	-	.740	.510	11 48
Vetch and oats,	3	9.91	1.299	9.58	1.349	.420	.663	.265	.098	.560	.521	6 59
Soja-bean straw,	1	13.00	.714	-	1.060	-	.436	.469	.035	.259	.218	3 92
Millet straw,	1	13.45	.690	-	1.760	-	-	-	-	.180	.580	4 63
White daisy,	1	9.65	.279	6.37	1.253	.164	1.302	.191	.032	.435	1.110	2 78
Dry carrot tops,	1	9.76	3.130	12.52	4.883	4.028	2.089	.667	.118	.612	.098	16 94
Barley straw,	2	10.01	1.125	5.30	2.408	.183	.572	.180	-	.216	2.380	7 18

* See note on page 439.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Continued.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
III. Roots, Bulbs, Tubers, etc.												
Beets, red,	8	87.82	.229	1.13	.440	.091	.049	.033	.004	.092	.020	$1 37
Beets, sugar,	4	86.95	.223	1.04	.477	.081	.057	.040	.013	.101	.018	1 40
Beets, yellow fodder,	1	90.60	.192	.95	.462	.104	.045	.030	.005	.086	.015	1 26
Mangolds,	2	87.29	.188	1.22	.383	.125	.061	.039	.005	.093	.023	1 17
Ruta bagas,	3	89.13	.190	1.06	.489	.070	.088	.030	.004	.123	.012	1 33
Turnips,	4	89.73	.171	1.01	.379	.078	.089	.027	.009	.115	.112	1 10
Carrots,	3	89.03	.155	9.22	.461	.062	.067	.023	.009	.090	.010	1 23
Parsnips,	1	80.34	.217	-	.617	.006	.088	.045	.005	.187	.019	1 63
Potatoes,	4	80.07	.293	.99	.510	.022	.015	.035	.002	.076	.029	1 11
Artichokes,	1	77.49	.460	-	.484	-	-	-	-	.168	.039	2 31
Japanese radish (*merinia*),	1	93.26	.081	-	.281	-	-	-	-	.047	-	0 64
Japanese radish (*niyas hige*),	1	92.58	.077	-	.338	-	-	-	-	.050	-	0 79
IV. Grains.												
Corn kernels,	13	10.88	1.822	1.53	.404	.034	.032	.206	.019	.699	.020	7 52
Corn and cob meal,	29	8.96	1.409	-	.472	.059	.018	.176	.011	.571	.430	6 02

Oat kernels,	1	9.04	2.100	-	-	-	-	-	-	-	-	-
Soja beans,	2	18.33	5.303	4.99	1.991	.275	.419	.909	.216	1.869	.093	22 63
Red adzinki beans,	1	14.82	3.240	-	1.540	.035	.090	.210	.180	.940	.050	14 07
White adzinki beans,	1	16.90	3.330	-	1.480	.190	.130	.220	.021	.970	.130	14 14
Saddle beans,	1	12.38	2.120	-	2.130	.020	.250	.430	.032	1.520	.250	11 28
Daidzu beans,	1	11.53	5.520	-	1.960	.210	.220	.400	.050	1.480	.280	22 96
Japanese millet,	2	13.68	1.730	-	.380	.030	.045	.225	.015	.685	-	7 16
Common millet,	1	12.68	2.040	-	.360	.060	.040	.260	.030	.850	.143	8 38
Chestnuts,	1	44.86	1.175	2.72	.632	-	.060	.135	.010	.392	.069	5 51
Cranberries,	1	89.41	.075	-	.097	-	.018	.013	.005	.028	-	0 40
Apples,	2	79.91	.130	.41	.190	.030	.030	.030	.003	.010	.003	0 57
V. Flour and Meal.												
Corn meal,	3	14.13	1.920	1.42	.337	.064	.034	.187	.015	.714	.060	7 80
Hominy feed,	1	8.93	1.630	2.21	.490	-	.180	.280	-	.980	-	7 22
Ground barley,	1	13.43	1.550	2.06	.341	.169	.091	.173	.013	.660	.069	6 46
Wheat flour,	2	12.14	2.020	1.22	.359	-	.170	.050	-	.352	-	8 89
Pea meal,	1	8.85	3.080	2.68	.993	.618	.302	.302	.027	.820	.122	12 69
Soja-bean meal,	1	10.80	5.89	-	2.230	-	-	-	-	1.570	.280	24 64
Peanut meal,	1	8.00	7.84	-	1.540	-	-	-	-	1.270	-	-
VI. By-products and Refuse.												
Linseed meal, old process,	4	8.02	5.390	6.57	1.214	.860	.664	.763	.060	1.780	.340	21 98
Linseed meal, new process,	5	7.96	5.828	5.04	1.246	.823	.663	.655	.062	1.692	.345	24 26

* See note on page 439.

B. Analyses of Fodder Articles with Reference to Fertilizing Ingredients — Concluded.

NAME.	Analyses.	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	*Valuation per 2,000 Pounds.
VI. By-products and Refuse — Concluded.												
Cotton-seed meal,	19	8.52	6.577	6.49	1.725	.291	.587	.589	.020	2.393	.323	$26 84
Wheat bran,	8	11.07	2.620	6.44	1.579	.159	168	.899	.019	2.461	.182	13 37
Wheat middlings,	2	10.15	2.745	2.30	.750	.110	.200	.210	-	1.245	-	11 67
Rye middlings,	1	12.54	1.840	3.52	.810	.030	.090	.320	.020	1.260	.170	8 59
Rye feed,	1	9.63	1.950	-	.980	-	-	-	-	1.561	-	9 46
Gluten meal,	5	8.53	5.090	.65	.047	.018	.050	.035	.009	.420	-	18 28
Gluten feed (Buffalo),	5	8.15	3.716	-	.064	-	-	-	-	.342	.160	13 45
Gluten meal (Chicago),	1	9.33	5.380	-	.071	-	-	-	-	.380	-	-
Gluten meal (King),	1	7.78	5.690	-	.079	-	-	-	-	.690	-	-
Distillery feed (Atlas mills),	1	11.21	5.300	-	.160	-	-	-	-	.230	-	-
Spent brewers' grain,	2	8.58	2.680	6.15	.853	.347	.296	.286	.159	1.045	1.770	11 36
Proteina,	1	10.06	2.970	-	.570	-	-	-	-	1.000	-	12 02
Damaged wheat,	1	13.10	2.260	-	.505	-	-	-	-	.831	-	9 30
Louisiana rice bran,	1	10.25	1.430	-	.840	-	-	-	-	1.710	-	7 64
Glucose refuse,	1	6.71	3.370	-	.090	-	-	-	-	.610	-	12 50

Cocoa dust,	1	7.10	2.299	6.350	.630	–	.630	–	–	1.340	–	10 08
Broom-corn waste (stalks),	1	10.37	.870	4.700	1.858	–	.232	.170	–	.460	1.000	5 55
Cotton hulls,	3	10.63	.750	2.610	1.080	–	.200	.260	–	.180	.060	3 99
Peanut feed,	2	9.99	1.460	–	.790	–	–	–	–	.230	–	–
Peanut husks,	1	12.98	.800	–	.480	–	–	–	–	.130	–	–
Meat meal,	1	8.00	11.210	–	.300	–	–	–	–	.730	–	–
Apple pomace,	2	80.50	.227	.271	.134	.026	.037	.028	.008	.018	.009	0 96
Corn cobs,	8	12.09	.594	.815	.598	.071	.025	.045	.009	.063	.190	2 48
Palmetto roots,	1	11.51	.540	3.930	1.380	.345	.045	.004	.017	.157	.410	3 57
Buckwheat hulls,	1	11.90	.490	–	.521	–	.247	.236	.020	.073	.066	2 36
VII. Dairy Products.												
Buttermilk,	1	91.13	.510	.810	.046	–	.045	–	–	.041	–	1 88
Skim-milk,	22	90.30	.585	.787	–	–	–	–	–	–	–	–
Whey,	1	93.68	.102	–	.0723	–	–	–	–	.173	–	0 62

* See note on page 439.

C. Analyses of Fruits.

NAME.	Date.	Dry Matter.	Specific Gravity of Juice.	Temperature C. of Juice (Degrees).	Total Sugar in Juice.	Glucose in Juice.	Cane Sugar in Juice.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.	Per ct.			Per ct.	Per ct.	Per ct.	C. C.
Apple (Baldwin), ...	Sept. 1,	20.14	1.055	12—15	3.09	-	-	-
Apple (Baldwin), ...	Oct. 9,	19.66	1.065	12—15	6.25	-	-	-
Apple (Baldwin), ...	Nov. 27,	-	1.075	12—15	10.42	-	-	-
Rhode Island Greening, . .	Sept. 1,	20.27	1.055	12—15	3.16	-	-	-
Rhode Island Greening, . .	Oct. 9,	19.68	1.066	12—15	7.14	-	-	-
Rhode Island Greening,† . .	Nov. 27,	20.25	1.080	12—15	11.36	-	-	-
Pear (Bartlett), ...	Aug. 31,	15.00	1.060	12—15	4.77	-	-	-
Pear (Bartlett), ...	Sept. 7,	16.55	1.060	12—15	5.68	-	-	-
Pear (Bartlett), ...	Sept. 20,	-	1.065	12—15	8.62	-	-	-
Pear (Bartlett),‡	Sept. 22,	-	1.060	12—15	8.93	-	-	-
Cranberries, ...	-	10.71	1.025	15	1.35	-	-	-§
Cranberries, ...	1878.	10.11	1.025	15	1.70	-	-	-‖
Early York Peach (ripe), .	-	-	1.045	25	-	1.92	6.09	45
Early York Peach (nearly ripe),	-	10.96¶	1.039	25	-	1.36	4.12	42.3
Crawford Peach (nearly ripe),	-	-	1.050	18	-	2.19	7.02	85.6
Crawford Peach (mellow), .	-	11.36¶	1.055	18	-	1.70	8.94	76
Crawford Peach (not mellow),	-	11.88¶	1.045	22	-	1.67	5.92	64

* One part Na_2CO_3 in 100 parts of water.
† Picked October 9.
‡ Picked September 7.
§ Free acid, 2.25 per cent.
‖ Free acid, 2.43 per cent.
¶ In pulp, kept ten days before testing.

C. Analyses of Fruits — Continued.

[Wild and cultivated grapes.]

NAME.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1876.			Per ct.	Per ct.	Per ct.	C.C.
Concord,	July 17,	1.0175	31	8.30	.645	7.77	-
Concord,	July 20,	1.0150	31	8.10	.625	7.72	216
Concord,	Aug. 2,	1.0200	25	9.94	.938	9.44	249
Concord,	Aug. 16,	1.0250	28	10.88	2.000	18.38	229
Concord,	Aug. 30,	1.0500	25	15.58	8.620	55.33	120
Concord,	Sept. 13,	1.0670	23	17.48	13.890	79.46	55
Concord,	Sept. 4,	1.0700	18	19.82	16.130	81.38	49.2
Wild Purple Grape,	July 19,	1.020	31	9.00	.714	7.93	204
Wild Purple Grape,	Aug. 4,	1.020	28	12.25	1.100	8.98	246
Wild Purple Grape,	Aug. 16,	1.025	28	12.48	2.000	16.03	233
Wild Purple Grape,	Aug. 30,	1.050	26	16.58	6.500	39.81	147.6
White Wild Grape,	Aug. 31,	1.050	26	16.48	9.260	56.18	98
Hartford Prolific,	Sept. 5,	1.060	22	17.39	13.89	79.87	88.8
Ives' seedling,	Sept. 6,	1.070	26	20.15	15.15	75.14	88.6
Iona,	Sept. 7,	1.080	21	24.56	15.15	61.68	144
Iona (mildewed),	Sept. 7,	1.045	26	15.41	6.25	40.56	204.4
Agawam,	Sept. 11,	1.075	20	20.79	17.24	82.92	94.8
Wilder,	Sept. 11,	1.064	20	16.53	13.67	82.69	56
Delaware,	Sept. 12,	1.080	24	23.47	17.86	76.09	74
Charter Oak,	Sept. 12,	1.080	24	15.98	8.77	54.94	168.3
Israella,	Sept. 16,	1.075	23	19.67	9.20	46.77	89.8
Bent's Seedling,	Sept. 20,	1.080	21	20.65	16.13	78.11	181.8
Adirondack,	Sept. 20,	1.065	21	15.11	13.17	87.16	68
Catawba,	Oct. 16,	1.080	13	23.45	17.39	74.16	82
	1877.						
Wilder,	Sept. 11,	1.065	23	16.41	15.15	92.32	60
Charter Oak,	Sept. 12,	1.055	23	16.22	9.80	60.42	96
Concord,	Sept. 13,	1.065	24	15.90	13.16	82.76	102
Concord,	Sept. 26,	1.075	24	19.34	15.43	79.78	70.8
Eumalan,	Sept. 24,	1.065	16	19.62	13.16	67.07	73
Wild White Grape,	Sept. 5,	1.050	22	15.57	7.20	46.24	140.8
Wild White Grape (shrivelled),	Sept. 20,	1.060	16	20.02	10.00	49.95	130
Wild Purple Grape (shrivelled),	Sept. 20,	1.045	16	16.69	8.22	49.25	104

* One part of pure Na_2 CO_3 in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of girdling on grapes.]

NAME AND CONDITION.	Date.	Specific Gravity.	Temperature C. (Degrees).	Dry Matter at 100° C.	Glucose in Juice.	Sugar in Dry Matter.	*Soda Sol. required to neutralize 100 parts Juice.
	1877.			Per ct.	Per ct.	Per ct.	C. C.
Hartford Prolific, not girdled,	Sept. 3,	1.045	19	12.85	8.77	68.25	111.4
Hartford Prolific, girdled,	Sept. 3,	1.065	19	17.18	12.50	72.76	100
Wilder, not girdled,	Sept. 3,	1.055	19	15.41	10.42	67.62	108.2
Wilder, girdled,	Sept. 3,	1.075	19	17.24	14.70	85.26	88.4
Delaware, not girdled,	Sept. 4,	1.065	19	15.75	11.76	74.66	101.2
Delaware, girdled,	Sept. 4,	1.075	19	19.14	15.15	79.16	94.4
Agawam, not girdled,	Sept. 4,	1.060	19	16.60	11.37	68.48	128.2
Agawam, girdled,	Sept. 4,	1.075	19	18.45	16.31	87.42	114.8
Iona, not girdled,	Sept. 6,	1.0625	22	16.60	13.51	68.31	131.4
Iona, girdled,	Sept. 6,	1.085	22	21.48	15.63	72.76	125.6
Concord, not girdled,	Sept. 6,	1.045	22	13.46	7.46	55.42	182.4
Concord, girdled,	Sept. 6,	1.070	22	17.53	13.88	79.18	102.8
Concord, not girdled,	Sept. 26,	1.065	22	17.63	13.70	78.27	86
Concord, girdled,	Sept. 26,	1.080	22	24.47	19.61	80.13	76.8
Concord, not girdled,	Oct. 5,	1.075	12	20.92	17.50	85.37	42
Concord, girdled,	Oct. 5,	1.085	12	–	17.86	–	54

	Date.	100 Parts of Grapes contained — Ash.	Moisture.	Glucose.	Tartaric Acid.
	1889.				
Concord, not girdled,	Sept. 23,	–	84.69	6.24	.75
Concord, girdled,	Sept. 23,	.42	83.00	8.13	.85
Concord, not girdled,	Oct. 8,	.53	84.51	6.09	.48
Concord, girdled,	Oct. 8,	.37	82.69	8.50	.50
	1890.				
Concord, not girdled,	Sept. 25,	.47	86.49	7.36	1.15
Concord, girdled,	Sept. 25,	.48	84.93	9.29	1.17
Concord, not girdled,	Oct. 9,	.53	85.39	7.67	.71
Concord, not girdled,	Oct. 9,	.59	85.11	6.65	.51
Concord, girdled,	Oct. 9,	.54	85.15	9.12	.74

* One part of pure $Na_2 CO_3$ in 100 parts water.

C. Analyses of Fruits — Continued.

[Effect of fertilization upon the organic constituents of wild grapes.]

NAME.	Date.	Dry Matter.	Specific Gravity.	Temperature C. (Degrees).	Per Cent. of Glucose.	Per Cent. of Acids.	Remarks.
	1877.						
Wild Purple Grape Berries, .	Sept. 20,	16.31	-	-	8.03	-	Unfertilized.
Wild Purple Grape Berries, .	"	19.55	-	-	13.51	-	Fertilized.
Wild Purple Grape Juice, .	"	-	1.045	16	8.22	9 840	Unfertilized.
Wild Purple Grape Juice, .	"	-	1.065	16	13.51	1.149	Fertilized.
Wild White Grape Berries, .	"	20.02	-	-	-	-	Unfertilized.
Wild White Grape Berries, .	"	21.65	-	-	-	-	Fertilized.
Wild White Grape Juice, .	"	-	[illegible]	16	[illegible]	1.846	Unfertilized.
Wild White Grape Juice, .	"	-	-	-	[illegible]	.923	Fertilized.

[Effect of fertilization upon the ash constituents of grapes.]

NAME.	Date.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.	Remarks.
	1876.								
Wild Purple Grapes,	Sept. 13,	50.93	.15	22.23	5.59	.79	17.40	2.93	Unfertilized.
Wild Purple Grapes,	Sept. 20,	62.65	.85	14.24	3.92	.53	13.18	4.63	Fertilized.
Concord Grapes, .	July 7,	41.73	5.04	25.03	7.50	.55	18.48	1.37	Unfertilized.
Concord Grapes, .	July 17,	47.34	1.13	24.21	-	.75	21.38	.43	Unfertilized.
Concord Grapes, .	Aug. 18,	51.14	3.19	16.20	6.38	.65	20.77	1.67	Unfertilized.
Concord Grapes, .	Sept. 13,	57.15	4.17	11.30	3.10	.40	12.47	11.82	Unfertilized.
	1878.								
Concord Grapes, .	Oct. 3,	64.65	1.42	9.13	3.63	.50	14.57	5.80	Fertilized.

C. Analyses of Fruits — Concluded.

[Ash analyses of fruits and garden crops.]

NAME.	Ash.	100 PARTS OF ASH CONTAINED — Potash.	Soda.	Lime.	Magnesia.	Ferric Oxide.	Phosphoric Acid.	Insoluble Matter.
Concord Grape (fruit),	–	51.14	3.19	16.20	6.38	.65	20.77	1.67
Unfermented juice,	–	50.85	.48	3.69	4.25	.10	6.43	.90
Fermented juice,	–	40.69	–	6.85	6.24	–	9.04	–
Skins and pulp,	–	7.70	.42	57.36	8.80	.08	24.40	1.32
Seeds,	3.08	6.71	–	–	3.03	–	17.20	.29
Stems of grapes,	4.69	20.91	–	20.20	8.45	–	17.75	2.09
Young branches,*	–	24.71	.94	40.53	10.66	1.08	17.16	4.92
Wood of vine,†	2.97	22.57	–	9.72	4.28	–	14.07	23.84
Concord Grapes, 1891,‡	.55	49.76	–	3.50	2.53	1.19	13.56	2.01
Clinton Grape (fruit),	–	58.45	3.51	13.34	7.37	.90	18.19	–
Baldwin Apple,	–	63.54	1.71	7.28	5.52	1.08	20.87	3.68
Strawberry (fruit),§	.52	49.24	3.23	13.47	8.12	1.74	18.50	5.66
Strawberry (fruit),‖	–	58.47	–	14.64	6.12	3.37	17.40	–
Strawberry vines,	3.34	10.62	13.35	36.63	3.83	6.91	14.48	14.17
Cranberry (fruit),	.18	47.96	6.58	18.58	6.78	–	14.27	–
Cranberry vines,	2.45	12.98	3.27	16.49	10.33	3.35	10.94	34.04
Currants, red,	.47	47.68	4.02	18.96	6.23	1.20	21.91	–
Currants, white,	.59	52.79	3.00	17.08	5.68	2.67	18.78	–
Crawford Peach, sound,	–	74.46	–	2.64	6.29	.58	16.02	–
Crawford Peach, diseased,¶	–	71.30	–	4.68	5.49	.46	18.07	–
Branch, sound,	–	26.01	–	54.52	7.58	.52	11.37	–
Branch, diseased,¶	–	15.67	–	64.23	10.28	1.45	8.37	–
Carnation Pinks (whole plant),**	8.80	38.07	12.84	18.64	3.98	.34	5.23	.24
Asparagus stems,	–	42.94	3.58	27.18	12.77	1.22	12.31	.08
Asparagus roots,	–	56.43	5.42	15.48	7.57	–	15.09	3.67
Onions,	–	38.51	1.90	8.20	3.65	.58	15.80	3.33

* With tendrils and blossoms.
† One year old.
‡ Nitrogen in dry matter, .96 per cent.
§ Wilder.
‖ Downing.
¶ Yellows.
** Nitrogen in dry matter, 1.15 per cent.

D. Analyses of Sugar-producing Plants.

[Composition of sugar beets raised upon the college grounds during the season of 1870 and 1871.]

NAME.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Sugar.	Non-saccharine Substances.
Electoral, ...	Sept. 10,	14	12.30	1.75
Imperial, ...	" 12,	15	12.59	2.41
Vilmorin, ...	" 13,	14.5	12.95	1.55
Imperial, ...	" 18,	14	10.79	3.21
Imperial, ...	Oct. 11,	15	12.05	2.95
Electoral, ...	" 16,	15	12.22	2.78
Vilmorin, ...	" 18,	16	13.13	2.87
Imperial, ...	Nov. 14,	15	11.60	3.34
Vilmorin, ...	" 21,	15.5	13.12	2.38
Vienna Globe,*	Sept. 19,	11	8.00	3.00
Common Mangold,* . . .	" 19,	9	5.00	3.97

* Fodder beets.

[Percentage of sugar in different varieties of sugar beets grown on college farm during the season of 1882.]

NAME.	Source of Seed.	Weight in Pounds.	Per Cent. of Sugar in Juice.
I. Vilmorin, ...	Saxony, .	$\frac{3}{4}$ to $\frac{7}{8}$	15.50
II. Vilmorin, ...	Saxony, .	$\frac{3}{4}$ to 1	15.61
I. White Imperial, ...	Saxony, .	$\frac{3}{4}$ to $1\frac{3}{4}$	14.20
II. White Imperial, ...	Saxony, .	$1\frac{3}{4}$ to 2	10.27
New Imperial, ...	Saxony, .	$1\frac{1}{4}$ to $1\frac{3}{4}$	13.80
I. White Magdeburg, ...	Saxony, .	$1\frac{1}{2}$ to 2	13.10
II. White Magdeburg, ...	Silesia, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	10.06
Quedlinburg, ...	Saxony, .	$1\frac{1}{2}$ to $1\frac{3}{4}$	13.44
White Silesian, ...	Silesia, .	$1\frac{1}{4}$ to $1\frac{1}{2}$	9.72

D. Analyses of Sugar-producing Plants — Continued.

[Effect of soil and fertilization on Electoral sugar beets.*]

SOIL.	MANURE.	Specific Gravity Brix (Degrees).	Per Cent. of Sugar in Juice.	Non-saccharine Substances.	Cane Sugar in Soluble Matter.
Sandy loam,	Fresh yard-manure,	16.5	12.50	4.00	75.08
Clayish loam,	Fresh yard-manure,	15.5	11.05	4.45	71.30
Warm alluvial,	Yard-manure and chemicals,	12.75	9.17	3.58	71.92
Warm alluvial,	Fresh hog-manure,	13.5	9.53	3.97	70.06
Light, sandy soil,	No manure,	18.5	13.73	4.77	74.21
Alluvial soil,	Brighton fish,	14.5	11.15	3.35	76.90
Heavy soil,	Yard-manure,	12.25	8.15	4.10	66.53
–	–	13.5	9.90	3.60	73.33

* Not raised on college farm (Connecticut valley).

[Effect of fertilization on sugar beets.*]

FERTILIZERS.	PERCENTAGES OF SUGAR IN JUICE.		
	Freeport.	Electoral.	Vilmorin.
Fresh horse-manure,	11.96	9.42	7.80
Blood guano without potash,	10.99	10.10	10.20
Blood guano with potash,	12.55	13.24	10.50
Kainite and superphosphate,	13.15	12.16	10.50
Sulphate of potash,	14.52	14.32	12.78
Second year after stable-manure,	13.49	12.78	12.19

* All were grown on the same soil, — sandy loam (college).

D. Analyses of Sugar-producing Plants — Continued.

[Effect of different modes of cultivation on Electoral sugar beets.]

Locality of Beet-field.	Date.	Brix Saccharometer (Degrees).	Per Cent. of Cane Sugar.	Non-saccharine Substances.
1. Sing Sing, N. Y.,	1872–73	11	7.80	3.20
2. Washington, N. Y.,	"	14	10.97	3.03
3. South Hartford, N. Y.,	"	15	11.70	3.30
4. Greenwich, N. Y.,	"	12	9.50	2.50
5. Frankfort, N. Y.,	"	13.5	11.00	2.50
6. Albion, N. Y.,*	"	18	15.10	2.90
Albion, N. Y.,†	"	14	9.70	4.30

* From beets weighing from 1½ to 2 pounds. † From beets weighing from 10 to 14 pounds.

1. Soil, loam resting on clayish hard-pan, had been for several years in grass. Tomatoes had been the preceding crop. Five hundred pounds of a phosphatic blood guano were applied before planting.

2. Soil, a clayish loam, had been ploughed seven inches deep. A liberal amount of rotten sheep-manure was placed in trenches and covered by running two furrows together, thus forming a ridge on which the seed were planted.

3. Soil, a gravelly loam, which had been richly manured with stable compost and twice ploughed before planting.

4. Soil, a sandy loam, underlaid by fine sand. The seed were planted on ridges, which covered trenches containing a little rotten stable-manure.

5. No details of modes of cultivation received.

6. Soil, a dark, reddish-brown, rich, deep, sandy loam. Clover had been raised for two years previous to a crop of carrots, which preceded the sugar beets. The beets were the second crop after the application of twenty loads of stable-manure per acre.

Composition of Canada-grown Sugar Beets.

[1872 and 1873.]

Where Grown.	Weight of Roots.	Specific Gravity of Juice (Brix).	Temperature of Juice.	Per Cent. of Cane Sugar in Juice.
Echaullon de Montreal,	2 to 2½ lbs.	15.4°	64° F.	11.38
Riviere du Loup,	2 to 3¼ lbs.	14.5°	63° F.	10.20
Chambly,	2 to 2½ lbs.	13.2°	63° F.	9.02
Maskinonge,	2 to 3 lbs.	13.4°	63° F.	8.83

D. Analyses of Sugar-producing Plants — Continued.

[Early Amber Cane.]

Date.	Condition of Cane.	Brix Saccharometer (Degrees).	Temperature C. (Degrees).	Glucose.	Cane Sugar.	Soda solution required to neutralize 100 parts of Juice.	Solids.
1879.				Per ct.	Per ct.	C. C.	Per ct.
Aug. 15,	No flower stalks in sight, * . .	4.2	27	2.48	None.	6.8	7.93
Aug. 16,	No flower stalks in sight, * . .	5.8	24	4.06	None.	9.0	11.10
Aug. 20,	Flower stalks developed,* . .	7.9	24	3.47	2.15	7.0	13.00
Aug. 24,	Flowers open,*	8.7	23	3.70	3.00	4.0	14.07
Aug. 27,	Plants in full bloom,* . . .	10.0	25	3.65	4.13	10.0	15.48
Aug. 30,	Seed forming,*	9.5	30	4.00	3.81	9.5	16.14
Sept. 2,	Seed in milk,*	10.7	27	3.85	4.41	9.5	15.85
Sept. 9,	Seeds still soft,*	12.1	22	3.21	6.86	9.5	26.13
Sept. 9,	Stripped on Sept. 2,*	12.8	22	3.77	6.81	9.5	26.75
Sept. 18,	Left on field without stripping,* .	13.2	22	3.57	7.65	–	–
Sept. 18,	Tops removed,*	13.8	22	3.16	8.49	–	–
Sept. 18,	Tops and leaves removed on Sept. 9,*	11.5	22	3.16	5.85	–	–
Sept. 18,	Tops removed; left on field 9 days,*	12.8	22	10.00	.60	–	–
Sept. 21,	Juice from the above,* . . .	13.0	21	–	–	–	–
Sept. 23,	Juice from the above,* . . .	15.0	18	–	–	–	–
Sept. 25,	Left on field 3 weeks,† . . .	19.8	21	11.91	6.27	–	–
Sept. 28,	Left on field 3 weeks,† . . .	17.8	12	16.60	–	–	–
Oct. 4,	Left on field 3 weeks,† . . .	16.1	17	8.62	6.16	12.0	–
Oct. 7,	Freshly cut. Ground with leaves,†	16.7	20	4.16	9.94	6.8	–
Oct. 8,	Freshly cut. Stripped two weeks,†	12.8	17	5.16	5.27	7.0	–
Oct. 9,	Freshly cut. Stripped two weeks,†	18.4	17	7.57	–	10.6	–
Oct. 14,	Several weeks old,†	18.2	15	10.42	–	10.4	–
Oct. 18,	Several weeks old,†	15.1	23	7.57	–	–	–
Oct. 19,	Several weeks old,†	15.5	15	9.22	–	13.6	–
Oct. 22,	Several weeks old,†	16.2	16	8.30	–	–	–
Oct. 23,	Several weeks old,†	18.3	17	11.30	5.5	14.0	–
Oct. 24,	Several weeks old,†	16.6	15	8.63	–	9.0	–

		100 Parts of Cane contained —				
		Moisture.	Glucose.	Cane Sugar.	Total Sugar.	
1889.						
October,	Early Tennessee sorghum, mature,	77.43	1.79	3.21	5.00	Grown on station grounds.
October,	Price's new hybrid, ripe, . . .	77.80	2.92	3.78	6.70	
October,	Kansas orange, green, . . .	80.67	2.38	3.63	6.01	
October,	New orange, green, ...	78.30	2.96	3.85	6.81	
October,	Honduras, green, ...	77.55	3.08	4.01	7.09	

* Raised on the college farm. † Raised by farmers in the vicinity of the college.

D. Analyses of Sugar-producing Plants — Concluded.

[Composition of the juice of corn stalks and melons.]

VARIETY.	Specific Gravity.	Temperature C. (Degrees).	Glucose.	Cane Sugar in Juice.	Solids.
			Per ct.	Per ct.	Per ct.
Northern corn,*	1.023	27	4.35	0.28	15.18
Black Mexican sweet corn,† . .	1.048	27	2.06	7.02	17.44
Evergreen sweet corn,† . . .	1.052	–	4.85	5.70	20.38
Common sweet corn,‡ . . .	1.035	–	6.60	None.	–
Common yellow musk-melon,§ .	1.040	26	1.67	2.65	–
White-flesh water-melon, . .	1.025	18	2.91	2.16	–
Red-flesh water-melon, . . .	1.025	22	3.57	2.18	–
Red-flesh water-melon, . . .	1.025	19	3.84	1.77	–
Nutmeg musk-melon,‖ . . .	1.030	19	3.33	2.11	–
Nutmeg musk-melon,¶ . . .	1.050	20	2.27	5.38	–
Nutmeg musk-melon,** . .	1.030	19	2.50	1.43	–

* Tassels appearing.
† Ears ready for the table.
‡ Kernels somewhat hard.
§ Fully ripe.
‖ Not ripe.
¶ Ripe.
** Over-ripe.

E. *Analyses of Dairy Products.*

		Solids.			Fat.			Curd.			Salt.			
	Analyses.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Ash.
Whole milk,	1,889	18.27	10.20	13.47	7.54	1.72	4.14	-	-	3.20	-	-	-	.70
Skim-milk,	348	10.48	7.68	9.48	1.02	.05	.32	-	-	3.53	-	-	-	.80
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	2.79	-	-	-	.80
Cream (from Cooley Creamer),	197	32.78	18.12	26.10	25.00	10.53	17.66	-	-	-	-	-	-	.62
Butter,	25	92.89	87.05	89.11	89.05	81.43	83.95	.89	.51	.66	6.45	3.46	4.74	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	-	-	22.13	-	-	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	-	-	26.63	-	-	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	-	-	30.37	-	-	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	-	-	31.99	-	-	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	-	-	33.24	-	-	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	-	-	34.94	-	-	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	-	-	28.63	-	-	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	-	-	25.94	-	-	-	4.50

* From analyses made in 1875.

E. *Salt for Meat Packing and Dairy Purposes.*

KIND AND SOURCE.	Moisture, 100° C.	Sodium Chloride.	Calcium Sulphate.	Calcium Chloride.	Magnesium Chloride.	Sodium Sulphate.	Magnesium Sulphate.	Insoluble Matter.	Remarks.
Rock salt of Pettite Anse, La.,	.330	98.882	.782	.004	.003	-	-	-	Sent on for examination.
Rock salt of Neyba, San Domingo, W. I.,	.300	98.330	1.480	-	.090	.070	.070	-	
Solar salt, Onondaga, N. Y.,	2.500	96.004	1.315	.092	.089	-	-	-	
Solar salt, Hocking Valley, O.,	2.130	97.512	None.	.234	.089	-	-	-	
Solar salt, Saginaw Valley, Mich.,	3.344	95.813	.316	.356	.140	-	-	-	
Solar salt from Kansas,	4.950	93.060	1.220	-	.240	.350	.180	-	
Solar salt, Lincoln County, Neb.,	1.200	98.130	.250	-	.080	.390	None.	-	
Common fine and boiled salt, Onondaga, N. Y.,	3.000	95.353	1.355	.155	.136	-	-	-	
Common fine and boiled salt, Portsmouth, Mich.,	6.752	90.682	.805	.974	.781	-	-	-	
Common fine and boiled salt, Mason City, O.,	3.470	95.789	-	.614	.041	-	-	-	
Dairy and table salt, Ashton's (English),	0.760	97.652	1.430	-	.060	-	.048	.050	
Onondaga dairy salt,	0.700	97.832	1.263	-	.037	.026	.023	.120	
Fine salt, Bulletin 26, I.,	3.280	95.091	1.487	.032	.075	-	-	.035	
Fine salt, Bulletin 26, II.,	4.591	94.012	1.177	.143	.049	-	-	.028	
Fine salt, Bulletin 26, III.,	4.616	94.236	.999	.071	.026	-	-	.052	Salicylic acid: trace.
Dairy salt, sent on from Amherst, Mass.,	0.145	98.520	1.009	.189	.065	-	-	.072	
Ashton salt (sent on),	.760	97.650	1.430	-	.060	-	.050	.050	
Onondaga factory-filled (sent on),	.600	98.280	.910	-	-	.030	.060	.120	
Dairy salt, sent on from Amherst,	.505	98.202	.877	.168	.046	-	-	.202	
Rock salt from Retsof salt mines,	2.600	95.940	.420	.330	.010	-	-	.700	
Royal salt,	.880	97.877	1.108	.016	.010	-	-	.102	
Excelsior salt,	.320	98.009	1.644	.013	.014	-	-	.020	
Genesee salt,	.295	98.513	1.160	.010	.012	-	-	.010	
Genesee salt,	.235	98.563	1.137	.045	.020	-	-	-	
Bradley salt,	.200	98.575	1.185	.029	.007	-	-	-	
Higgins' Eureka salt,	.855	98.891	.906	.203	.055	-	-	-	
Worcester refined salt,	.565	97.935	1.376	.097	.027	-	-	-	

F. Analyses of Insecticides.

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Insoluble Matter.
Paris green,	1.30	62.55	32.84	3.10	-	-	-	-	-	-	-	-	0.21
Paris green,	1.41	61.40	33.20	3.90	-	-	-	-	-	-	-	-	0.09
Paris green,	1.40	61.15	33.10	3.71	-	-	-	-	-	-	-	-	0.64
Paris green,	1.15	53.91	31.27	8.10	-	-	-	-	-	-	-	-	0.04
Paris green,	1.34	61.25	33.35	3.93	-	-	-	-	-	-	-	-	0.13
Paris green,	1.31	61.21	33.45	3.94	-	-	-	-	-	-	-	-	0.09
Paris green,	1.15	59.92	30.40	-	-	-	-	-	-	-	-	-	0.10
Paris green,	1.27	54.80	30.85	6.50	-	-	-	-	-	-	-	-	0.12
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	0.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	0.78	-	0.48	0.27	-	0.26	0.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	0.23	-
Tobacco liquor,	40.89	-	-	-	0.53	-	-	-	-	1.47	16.34	0.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	0.57	0.33	-	-	-	-	49.66	-	41.18	-	-	2.31

VI. Tables of the Digestibility of American Feed-Stuffs.

Experiments made in the United States.

Compiled by J. B. LINDSEY.

I. Experiments with Ruminants.

II. Experiments with Swine.

Dec. 31, 1894.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom),	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom),	4	7	47.0—61.1 53	48.4—62.3 54	37.2—56.8 46	34.6—61.1 54	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials),	10	22	58	58	53	61	48	63
Hay of mixed grasses (medium in protein*),	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein),	4	14	54—62 58	- -	56—66 60	44—57 49	56—64 59	56—63 59
Hay of vetch and oats,	1	2	58—58 58	- -	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured),	1	2	54.3—55.3 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay,	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Hay of blue-joint grass (past bloom),	1	1	40	42	37	37	57	43
Hay of blue joint grass (bloom),	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom),	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given),	1	2	57.5—60 59	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56

Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	-	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	- -	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soja-bean hay,	1	2	61.9—62.7 62	- -	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	- -	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70
Cow-pea-vine hay (fair quality),	1	2	- 59	- -	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	- 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	1	2	56.8—65.4 62	- -	42.6—58.1 50	35.1—54 46	66.5—70 69	63.4—73.6 69
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	61—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2	-	-	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	-	-	43	48	69	72

* Below ten per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Corn Fodders (partially Air Dry).								
Corn stover (whole plant),	1	4	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (tops and blades),	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59
Corn stalk (below ear),*	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),*	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,*	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves (below ear),*	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 35	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	5	10	63—70 68	- -	43—61 54	72—82 78	43—61 53	68—81 76
Average both kinds,	-	-	70	-	65	74	59	74
Dent (in milk) field corn fodder,	5	11	58.8—66 63	- -	50—71 64	67—79 75	44—51 50	61—69 66

Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	- -	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—73 64	57—73 68
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6—68.3 64	61.2—69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9—62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cat's-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	- -	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.3—60 59
Johnson-grass hay,	1	1	55	-	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	- -	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	-	64	46	14	65
Cotton-seed hulls,	4	13	35—47.5 41	- -	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	- -	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	-	64	78	61	76
Dent corn fodder (glazing),	5	9	67	-	51	78	54	75

* Made at Maryland Experiment Station. It will be noticed that the coefficients of protein digestibility are very much below those obtained in other experiments. The animals were fed but six pounds each per day, with no other food, and it is probable that the metabolic nitrogen products excreted were in a measure at least the cause of the low results obtained.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Green Fodders — Concluded.								
Dent corn fodder (mature),	2	4	65	–	55	73	51	72
Average (glazing and mature),	7	13	66	–	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	– –	46—47 46	74—82 78	20—28 24	87—61 59
Sweet corn fodder (milk),	1	2	77—78 77	– –	74—76 75	73—74 74	77—78 77	80—81 81
Early amber sorghum (just after blossom),	1	2	60.9—61.7 61	– –	41.7—45.3 42	67 –	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	– –	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	–	59	74	46	74
Green grass (young),	1	1	69	–	74	55	65	72
Same (dry),	1	1	71	–	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	– –	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	–	–	71	–	76	63	70	73
Soiling rye (formation of head),	1	2	73.2—74 74	– –	78.9—80.4 80	73.6—74.8 74	78.6—79.7 79	69.7—71.4 71
Soiling clover (late blossom),	1	2	64.9—67.3 66	– –	52.3—52.9 53	63—66.1 65	65.8—68.3 67	76.1—79.3 78
Hungarian grass (probably in bloom),	1	4	61—67 63	63.4—68.8 66	65.4—71.7 68	47.8—56 52	59.4—66.4 62	63.5—68.4 66

Corn Silage.								
Dent silage (immature),	4	10	60—68 64	– –	71—78 71	64—85 72	42—65 52	60—70 66
Dent silage (milk),	4	12	60—74 65	– –	45—80 64	78—90 87	45—63 52	63—73 69
Dent silage (average of both),	8	23	65	–	68	80	52	67
Dent silage (stage uncertain, North Carolina),	1	4	53—67 60	– –	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing),	3	8	68—78 75	66—80 77	75—78 77	– 80	48—73 65	71—83 79
Fine crushed silage (steers),	1	2	60.4—68 64	– –	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep),	1	2	51.5—56 54	– –	59.5—67.7 64	67.5—69 65	21—22 21.5	52.6—57.3 55
Corn silage (raw, ears mature),	1	1	–	–	59	86	45	71
Same (cooked),	1	1	–	–	70	87	39	75
Sweet corn ensilage (occasional ears mature),	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soja-bean ensilage,	1	2	52.2—65.8 59	– –	47.1—62.5 55	66.4—77.3 72	71.3—80.2 76	45.9—58.2 52
Roots, Tubers, etc.								
Potatoes,	1	3	73.3—80.1 77	74.6—81.2 78	– –	13 –	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	– –	69.7—79.8 75	90.8—91.9 91

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Roots, Tubers, etc. — Concluded.								
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2 - 117 100	82.5—92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains.								
Corn meal (maize),	2	5	83—98 88	– –	– –	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	– –	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	– –	65—86 76	– 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	– –	62—69 66	68—75 72	44—50 47	50—53 51
Soja-bean meal,	1	2	78—86 82	– –	48—94 71	81—90 86	90—92 91	76—77 76
By-products.								
Cotton seed meal,	2	6	67—82 76	– –	– 32	87—100 93	83—96 88	44—75 64
Gluten meal,	1	2	85—90 87	86—92 89	– 33	86—90 88	83—90 87	88—94 91

Chicago gluten meal,	1	2	92–94 93	– –	4–39 22	96–98 97	89–92 90	96–97 97
King gluten meal,	1	2	84–87 85	– –	– –	92–98 95	– 92	82–86 84
Average gluten meals,	3	6	83	–	–	93	90	91
Buffalo gluten feed (one lot),	1	2	76–80 78	– –	40–46 43	81–82 81	84–86 85	78–84 81
Buffalo gluten feed (another lot),	1	2	89–91 90	– –	91–105 100	93–96 94	89–89 89	89–90 89
Peoria gluten feed,	1	2	84–87 86	– –	59–97 78	76–82 79	81–85 83	90–90 90
Chicago maize feed,	1	2	86–88 87	– –	78–86 82	91–92 92	85–86 85	86–90 88
Winter-wheat bran,	1	3	61–66 64	– –	5–56 28	53–80 65	78–79 78	70–72 71
Spring-wheat bran,	1	2	62–63 63	– –	22–25 24	76–76 76	78–82 80	70–71 70
Average all wheat brans,	4	9	61	63	22	71	78	69
Wheat middlings,*	1	2	72.6–72.2 75	75.1–79.3 77	– –	84.1–86.1 85	78.4–79.4 79	80.7–84.5 83
Wheat middlings,†	1	2	79.48–85.63 83	– –	32.57–40.06 36	81.71–87.98 85	81.83–87.75 85	84.43–91.08 88
New process linseed meal,	1	3	77–83 80	– –	49–90 74	90–102 94	83–88 85	85–87 86
Old-process linseed meal,	1	3	75–82 79	– –	38–71 57	85–92 89	86–93 89	76–79 78
Atlas meal,	1	2	80–80 80	– –	95–116 106	90–92 91	73–73 73	84–85 84

* Jordan.

† Very fine and quite light in color.

Table of the Digestibility of American Feed Stuffs — Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By products — Concluded.								
Rye meal,	1	2	85—90 87	– –	– –	63—65 64	83—85 84	89—94 92
Peanut feed,	1	2	32—32 32	– –	10—13 12	89—90 90	70—71 71	41—58 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 62	– –	50—55 53	89—93 91	78—81 79	59—59 59
Corn cobs,	1	2	59—60 59	– –	65—66 65	44—56 50	13—22 17	60—60 60
II. Experiments with Swine.								
Maize kernels (whole),	1	1	83	83	33	46	69	89
Maize meal,	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1	1	80	80	49	57	81	87
Wheat shorts,	1	2	74—79 77	– –	25—48 37	– –	71—75 73	85.5—88 87
Wheat bran,	1	2	53.7—68.6 61	– –	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs: —

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891, 1893.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890, 1891, 1892, 1893.

Bulletins 87 *d*, 80 *c*, 81 and 97 of the North Carolina Experiment Station.

Bulletin No. 16, Utah Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletin No. 26 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletin No. 20 of the Maryland Experiment Station.

Eleventh and Twelfth Annual Reports (1893 and 1894) of the Massachusetts State Experiment Station.

METEOROLOGY.

C. H. Johnson.

1894.

The meteorological observations have been continued as in previous years. The temperature, the force and the direction of the wind and the amount of cloudiness, are recorded each day, at 7 A.M., 2 P.M. and 9 P.M. During the summer months the reading of a wet-bulb thermometer takes place at the same time. Records are also taken of maximum and minimum temperatures, rainfall, and of casual meteorological phenomena.

Monthly and annual reports are sent to the headquarters of the New England Weather Service at Boston.

The most conspicuous meteorological phenomena of the past year (1894) will be briefly considered here, while the following tables will show the average monthly temperature, precipitation, prevailing direction of the wind, etc.

The mean temperature for January, February and March, viz., 28.03°, was above the normal, and 6.15° above that for the first three months of 1893. The precipitation, viz., 6.28 inches, was about 4 inches below normal, and 5.59 inches below that for the same season in 1893.

There were 4 inches of snow on the ground at the beginning of the year, but this had nearly all disappeared by the 15th of January. On the 27th of January 5 inches of snow fell, and on the 29th and 30th there was a storm giving 10 inches, so there were 13 inches of snow on the ground at the end of the month.

The daily mean temperature for January, viz., 25.43°, was about 5° above the normal, and was 10.95° above that of January, 1893, as recorded at this station. The precipitation was much below the normal.

The mean temperature for February, viz., 19.68°, was about 4° below the average. On the morning of the 25th the minimum reading was — 18°. The mean temperature for the 24th was — 1° and for the 25th — 2.5°, these being the two coldest days of the year. The precipitation was much below the normal, but the ground was well protected with snow during the greater part of the month.

The month of March was warm and dry. The daily mean temperature, viz., 39°, was nearly 10° above the normal, and was 9.4° above that of March, 1893. The precipitation, viz., 1.68 inches, was nearly 2 inches below the average.

April was also characterized by being unusually warm and pleasant. The daily mean temperature, viz., 45.6°, was about 2° above the normal. The precipitation, viz., 1.60 inches, was 2 inches below the average for that month. There was a storm on the 8th giving 4 inches of snow, and one on the 12th and 13th giving 2 inches. This was the last snowfall of the season. April being so warm and dry, farmers were enabled to get most of their land in condition for planting, and some had planted potatoes, onions, mixed forage crops, etc., by the 25th.

The mean temperature for May was about the average. The mercury reached the freezing point several times. On the morning of the 15th the minimum reading was 28°. The precipitation was about normal, but most of it occurred during the last week of the month. The dry weather during the first two weeks of the month retarded the germination of seeds and growth of plants. Frosts on the 15th and 22d injured those crops that were up, and damaged fruit, especially on low lands. The frost of the 22d was the last of the season.

The mean temperature for June, viz., 67.53°, was about 3° below the normal. The rainfall was 5 inches below the average, and most of it occurred during the first and last part of the month, while the middle was hot and dry. The month was favorable for the growth of all crops. Haying was quite general by the 15th.

The month of July was hot and dry. The daily mean temperature, viz., 71.9°, was about 4° above the normal, while the rainfall, viz., 1.60 inches, was nearly 3 inches

below, and 1 inch below that for July, 1893. The absolute maximum temperature was 98°, occurring on the 20th.

August was extremely dry. The mean temperature was about normal, while the precipitation, viz., 32 inches, was nearly 4 inches below.

The continued drought of July and August caused great damage to farmers, seriously injuring crops, drying up wells and springs, so that in many instances the water supply was almost or entirely shut off.

The first frost of the season occurred on the 22d of August, and slightly injured vegetation on low lands.

The mean temperature for September and October was about 3° above normal, and the rainfall about normal. These months were favorable for the ripening and harvesting of crops.

The mean temperature for November was about normal, while the precipitation was 5 inches below. A trace of snow fell on the 5th, which was the first of the season.

For December the mean temperature was about normal, while the precipitation was slightly below.

The precipitation has not been sufficient to fill up the wells and springs, and now there is a scarcity of water in many localities.

Summary of Meteorological Observations, 1894.

	Temperature, Degrees Fahrenheit.														
	7 A.M.	2 P.M.	9 P.M.	Mean Maximum.	Mean Minimum.	Mean.	Absolute Maximum.	Date.	Absolute Minimum.	Date.	Greatest Daily Range.	Date.	Least Daily Range.	Date.	Mean Daily Range.
January,	21.13	30.83	25.64	34.84	16.39	25.43	45.00	22d	0	29th	34.00	2d	6.00	5th	18.45
February,	16.93	28.53	21.64	30.93	8.85	19.68	46.00	8th	—18.00	25th	47.00	17th	10.00	9th	22.08
March,	34.54	47.64	38.00	49.51	28.48	39.00	73.00	19th	20.00	4th, 26th	32.00	18th	11.00	14th, 29th	21.03
April,	41.63	55.00	44.76	56.80	34.40	45.60	77.00	27th	14.00	3d	40.00	16th	5.00	8th	22.40
May,	52.48	66.42	54.03	69.48	43.45	56.45	84.00	1st, 2d	28.00	15th	42.00	14th	10.00	31st	26.03
June,	63.76	76.90	65.76	79.20	55.86	67.53	93.00	17th	37.00	8th	39.00	14th	11.00	29th	23.34
July,	67.50	82.00	70.40	84.80	59.10	71.90	98.00	20th	48.00	10th, 11th, 23d	34.00	23d	14.00	5th	25.70
August,	61.40	78.30	65.10	80.40	53.50	66.90	91.00	24th	36.00	22d	42.00	22d	9.00	30th	26.90
September,	57.16	73.10	62.30	76.00	51.46	63.73	91.00	10th	32.00	26th	40.00	13th	8.00	19th	24.53
October,	45.70	58.90	48.30	60.20	40.40	50.30	73.00	20th	29.00	19th	33.00	20th	5.00	25th	19.87
November,	31.80	39.46	33.46	41.70	25.83	37.10	65.00	3d	9.00	20th	27.00	2d	6.00	8th, 9th	15.86
December,	21.48	32.93	24.84	34.67	15.64	25.16	49.00	15th	—7.00	28th, 30th	36.00	6th	6.00	8th, 9th, 12th	19.03
Sums,	515.51	670.01	554.23	698.58	433.36	569.78	-	-	-	-	-	-	-	-	265.22
Means,	42.98	55.83	46.18	58.21	36.11	47.48	-	-	-	-	-	-	-	-	22.10

Summary of Meteorological Observations, 1894.

	Precipitation, Inches.					Wind.	Casual Phenomena. — Dates.			
	Total Amount.	Date of Greatest Fall.	Total Snowfall.	Depth of Snow the 15th.	Depth of Snow at End of Month.	Prevailing Direction.	Thunder-storms.	Solar Halos.	Lunar Halos.	Aurora.
January,	2.43	29, 30,	20.20	.50	13.00	N. W. and N.	– –	9, 15, 26,	13,	3,
February,	2.17	9, 10,	18.25	13.00	5.00	N. W.	– –	5, 12, 17, 25,	14, 17, 18, 20,	22, 23,
March,	1.68	22, 23,	2.00	2.00	–	S. W.	– –	12, 13, 15, 20, 22,	12, 20,	2, 30,
April,	1.60	21, 22,	6.00	3.00	–	N.	27, 28,	1, 16, 30,	16, 18,	–
May,	3.80	18, 19,	–	–	–	S. W.	2, 6, 18, 19,	14, 16,	16,	–
June,	3.43	2, 3,	–	–	–	S. W.	18, 19, 27, 30,	–	14,	–
July,	1.60	21, 22,	–	–	–	S. W. and S.	3, 4, 6, 14, 17, 21, 25, 29,	–	22,	–
August,	.32	3,	–	–	–	S.	3, 15, 19, 30,	–	–	–
September,	4.11	19, 20,	–	–	–	S.	10, 16, 20,	–	–	–
October,	4.40	9, 10,	–	–	–	S.	– –	–	–	–
November,	3.09	3,	3.00	–	–	N.	– –	–	–	–
December,	3.45	11, 12,	22.00	–	7.00	N.	– –	19, 24, 26,	7, 10, 19,	–
Sums,	32.08	–	71.45	–	–	–	– –	–	–	–

Summary of Meteorological Observations, 1894.

January, February, March, April.

	1893.	Date.	1894.	Date.
Mean temperature,	26.89°	-	32.43°	-
Absolute maximum temperature,	66.00°	April 1,	77.00°	April 27.
Absolute minimum temperature,	—13.00°	Jan. 17,	—18.00°	Feb. 25.
Mean monthly range,	19.34°	-	20.99°	-
Total precipitation (inches),	15.53	-	7.88	-
Total snowfall (inches),	71.25	-	46.45	-
Last snowfall (inches),	trace	April 21,	2.00	April 12.

May, June, July, August.

Mean temperature,	64.47°	-	65.69°	-
Absolute maximum temperature,	94.00°	Aug. 10,	98.00°	July 20.
Absolute minimum temperature,	31.00°	May 8,	28.00°	May 15.
Mean monthly range,	24.12°	-	25.52°	-
Last frost,	-	May 8,	-	May 22.
Total precipitation (inches),	13.38	-	9.15	-

September, October, November, December.

Mean temperature,	42.29°	-	44.07°	-
Absolute maximum temperature,	81.00°	Sept. 10,	91.00°	Sept. 10.
Absolute minimum temperature,	—13.00°	Dec. 14,	—7.00°	Dec. 28, 30.
Mean monthly range,	21.82°	-	19.25°	-
First frost,	-	Sept. 3,	-	Aug. 22.
Total precipitation (inches),	14.31	-	15.05	-
First snowfall (inches),	trace	Nov. 4,	trace	Nov. 5.
Total snowfall (inches),	15.25	-	25.00	-

Entire Year.

Mean temperature,	44.55°	-	47.39°	-
Total precipitation (inches),	43.22	-	32.08	-
Total snowfall (inches),	86.50	-	71.45	-

LIST OF EXCHANGES.

Reports and Bulletins of the United States Department of Agriculture, Washington, D. C.
Reports and Bulletins of the Agricultural Experiment Stations of the United States.
Bulletins of the State Board of Agriculture, Boston, Mass
Bulletins of the Massachusetts Horticultural Society.
The American Cultivator, Boston, Mass.
The Holstein-Friesian Register, Boston, Mass.
Farm-Poultry Monthly, Boston, Mass.
Massachusetts Ploughman, Boston, Mass.
New England Farmer, Boston, Mass.
The Home and Mart, East Boston, Mass.
The American Nation, Boston, Mass.
New England Homestead, Springfield, Mass.
Farmers' Advocate, St. Albans, Vt.
Mirror and Farmer, Manchester, N. H.
New York Weekly World, New York, N. Y.
German Agricultural and Horticultural Journal (German), New York, N. Y.
American Agriculturist, New York, N. Y.
The Florists' Exchange, New York, N. Y.
Vick's Magazine, Rochester, N. Y.
The American Analyst, New York, N. Y.
Naturalist Monthly Bulletin, Philadelphia, Pa.
The Practical Farmer, Philadelphia, Pa.
The Farm Journal, Philadelphia, Pa.
The National Stockman and Farmer, Pittsburgh, Pa.
Contributions from the Botanical Laboratory of the University of Pennsylvania, Philadelphia, Pa.
Veterinary Magazine, Philadelphia, Pa.
Dorset Quarterly, Washington, Pa.
Chester County Village Record, West Chester, Pa.
Maryland Farmer, Baltimore, Md.
Baltimore Weekly Sun, Baltimore, Md.
Creamery and Dairy, Waterloo, Iowa.
The Agricultural Epitomist, Indianapolis, Ind.
The New Agricultural Era, Indianapolis, Ind.
The Clover Leaf, South Bend, Ind.

The Orange Judd Farmer, Chicago, Ill.
The Western Swineherd, Geneseo, Ill.
Elgin Dairy Report, Elgin, Ill.
The Dairy Messenger, Chicago, Ill.
The Dairy World, Chicago, Ill.
German Agricultural and Horticultural Journal, Chicago, Ill.
Detroit Free Press (weekly), Detroit, Mich.
University Record, Ann Arbor, Mich.
Farmers' Home Weekly, Dayton, Ohio.
American Grange Bulletin, Cincinnati, Ohio.
Journal of Columbus Horticultural Society, Columbus, Ohio.
The Louisiana Planter, New Orleans, La.
Hoard's Dairyman, Fort Atkinson, Wis.
Hospoda (Bohemian Journal), Omaha, Neb.
The Industrialist, Manhattan, Kan.
The Home and Farm, Louisville, Ky.
The Industrial American, Lexington, Ky.
Journal of the Elisha Mitchell Scientific Society, Chapel Hill, N. C.
Southern Cultivator, Atlanta, Ga.
Monthly Florida Bulletin, Tallahassee, Fla.
West American Scientist, Los Angeles, Cal.
California Cultivator and Poultry Keeper, Los Angeles, Cal.
Journal of the Geographical Society of California, San Francisco, Cal.
Publications of the Department of Agriculture, Quebec, Canada.
The Journal of Agriculture, Montreal, Canada.
Bulletins of the Central Experiment Farm, Ottawa, Canada.
Industrial Journal of Agriculture, Montreal, Canada.
Agricultural Student's Gazette, Cirencester, England.
Journal of Microscopy and Natural Science, Bath, England.
Lawes and Gilbert, Rothamstead, England.
British Dairy Farmers' Association, London, England.
British Dairy Farmer and Dairy World, London, England.
Landwirtschaftliche Blätter, Cassel, Germany.
Jahresbericht der Samen Control Station, Vienna, Austria.
Berichte der Landwirtschaftliche Verssuchstation, Halle, Germany.
Bulletins Ministere de l'Agriculture, Paris, France.
Bulletins of the College of Agriculture, Tokio, Japan.
Bulletins of the Department of Agriculture, New South Wales, Australia,
Agricultural Gazette, New South Wales, Australia.
Bulletins of the Department of Agriculture, Brisbane, Queensland, Australia.
Garden and Field Journal, South Australia.
Journal of the Council of Agriculture, Hobart, Tasmania.
Relatorio, Annual da Estacao Agronomica de Campinas, Sao Paulo Brazil.
Ragguagli, Laboratorio Chimico Agrario di Bologna, Bologna, Italy.
Reglamento, etc , Estacion Agronomica del Instituto Agricolo de Alfonso XII., Madrid, Spain.
Bulletins, Sculola Superiore d' Agriculture, Portugal.

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